U.S. Department of Energy
Hanford Site

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JUN 3 2004

04-TPD-056

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EDMC

Mr. Michael A. Wilson, Program Manager
Nuclear Waste Program
State of Washington
Department of Ecology
3100 Port of Benton Blvd.
Richland, Washington 99352

Dear Mr. Wilson:

MODIFICATION OF THE HANFORD FACILITY DANGEROUS WASTE, PART B PERMIT APPLICATION FOR THE INTEGRATED DISPOSAL FACILITY (IDF), DOE/RL-2003-12, REVISION 1, INCORPORATING A SECONDARY LEAK DETECTION SYSTEM (SLDS)

References:
1. ORP letter from R. J. Schepens to M. A. Wilson, Ecology, "Secondary Leak Detection Capability for the Integrated Disposal Facility (IDF)," 04-TPD-045, dated April 8, 2004.
2. DOE letter from R. J. Schepens and K. A. Klein to M. A. Wilson, Ecology, "Submittal of the Hanford Facility Dangerous Waste, Part B Permit Application for the Integrated Disposal Facility (IDF), DOE/RL-2003-12, Revision 1," 04-TPD-021, dated February 24, 2004.
3. Ecology letter from S. Dahl to R. Schepens, DOE-ORP, "Office of River Protection – Integrated Disposal Facility Dangerous Waste Permit Application (DOE/RL-2003-12 Revision 0)," dated February 18, 2004.

In accordance with the Reference 1 letter, the U.S. Department of Energy (DOE), Office of River Protection (ORP) has added a Secondary Leak Detection System (SLDS) to the design of the IDF. The IDF Part B Permit Application, Revision 1, submitted with the Reference 2 letter has been revised to incorporate this modification and other minor changes. A certification statement for this revision is provided in Enclosure 1. Revised sections and an index of section changes are provided in Enclosure 2. Please note that only revised sections of the application are being submitted as the modification.

We believe that this modification fully addresses the "vadose monitoring" issue described in Reference 3. However, the SLDS is not a design requirement of the Washington Administrative Code 173-303-665. DOE is adding this design feature pursuant to its regulatory authority under the Atomic Energy Act of 1954 and not for purposes of compliance with the dangerous waste regulations. Therefore, the SLDS design features contained in the attached modification are being provided as a matter of comity.

Pursuant to Revised Code of Washington (RCW) 42.17.310(1)(ww) and RCW 70.74.285, DOE has designated portions of the Part B permit application as national security sensitive (pages marked as "OFFICIAL USE ONLY"). Based on this national security sensitive designation, DOE requests that those portions of the permit application identified as "OFFICIAL USE ONLY" be withheld from public inspection and copying.

The Reference 3 letter also identified two other issues. The first issue concerns provision of the State Environmental Policy Act coverage provided by the Hanford Solid Waste Environmental Impact Statement (DOE/EIS-0286). The second issue involves the development of Waste Acceptance Criteria. This issue is related to compliance with DOE Order 435.1, Radioactive Waste Management. We believe that resolution of these issues will require further collaboration to ensure that the respective regulatory authorities of DOE and the Washington State Department of Ecology are properly maintained.

If you have any questions, please contact us, or your staff may contact Richard (Rick) McNulty, Environmental Division, (509) 373-9304, or Phil E. Lamont, Tank Farms Programs and Projects Division, (509) 376-6117 of the DOE Office of River Protection.

Roy J. Schepens, Manager
Office of River Protection

for Keith A. Klein, Manager
Richland Operations

TPD:PEL

Enclosures: (2)

cc: See page 3

cc w/o attach:
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P. Sobotta, NPT
A. W. Conklin, WDOH
R. Jim, YN
Administrative Record (w/attach)
Environmental Portal, LMSI (w/attach)

Enclosure 1
04-TPD-056

MODIFICATION TO THE INTEGRATED DISPOSAL FACILITY PART B APPLICATION CERTIFICATION STATEMENT

(Consisting of 2 pages,
including coversheet)

MODIFICATION TO THE INTEGRATED DISPOSAL FACILITY PART B APPLICATION
CERTIFICATION STATEMENT

The following certification, required by WAC 173-303-810(13), for all applications and reports submitted to Ecology is hereby included:

I certify under penalty of law that the modification[1] to DOE/RL-2003-12 Revision 1 was prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

6/3/04
Date

for Owner/Operator
Keith A. Klein, Manager
U.S. Department of Energy,
Richland Operations Office

5/27/04
Date

~~Owner/O~~perator
Roy J. Schepens, Manager
U.S. Department of Energy,
Office of River Protection

5/24/04
Date

Co-operator
Edward S. Aromi, Jr.,
President and General Manager
CH2M HILL Hanford Group, Inc.

[1]Modification refers to supplemental information on the Secondary Leak Detection System as provided in Enclosure 2.

* Co-operator under the U.S. Department of Energy, Office of River Protection Contract DE-AC27-99RL14047.

Enclosure 2
04-TPD-056

REVISIONS AND INDEX TO THE NTEGRATED DISPOSAL FACILITY PART B APPLICATION

(Consisting of 226 pages, including coversheet)

INDEX FOR SECTION CHANGES

Hanford Facility Dangerous Waste Permit Application, Integrated Disposal Facility, DOE/RL-2003-12, Modification (5/2004) to Revision 1,

<table>
<tr><th>LOCATION IN APPLICATION</th><th colspan="2">PAGES TO BE REPLACED</th></tr>
<tr><td>Chapter 2, Facility Description and General Provisions
(Volume 1 of 4)</td><td colspan="2">Replace:
2-i (Table of Contents)
2-1 through 2-4
F2-3 (Figure 2-2)
F2-9 & F2-10 (Figure 2-5)</td></tr>
<tr><td>Chapter 4, Process Information
(Volume 1 of 4)</td><td colspan="2">Replace:
4-i and 4-ii (Table of Contents)
4-1 through 4-24</td></tr>
<tr><td>Chapter 6, Procedures to Prevent Hazards
(Volume 1 of 4)</td><td colspan="2">Replace:
6-i (Table of Contents)
6-1 through 6-8
T6-1 (Table 6-1)</td></tr>
<tr><td>Appendix 4B, Construction Quality Assurance Plan
(Volume 1 of 4)</td><td colspan="2">Replace:
Entire Appendix</td></tr>
<tr><td rowspan="4">Appendix 4A, 100% Design Report
(Volume 4 of 4)</td><td colspan="2">Replace drawings:</td></tr>
<tr><td>H-2-830824
H-2-830825
H-2-830829 sheet 1 & 2
H-2-830831
H-2-830833
H-2-830837
H-2-830839
H-2-830845</td><td>H-2-830846
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H-2-830867
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2.0 FACILITY DESCRIPTION AND GENERAL PROVISIONS [B]

The Integrated Disposal Facility (IDF) will consist of an expandable lined landfill located in the 200 East Area on the Hanford Facility. The landfill will be divided lengthwise into two distinct cells, one for disposal of low-level radioactive waste and the other for disposal of mixed waste. The cell for disposal of low-level radioactive waste will be outside the scope of this permit application. The mission of the IDF will include the following functions:

- Provide an approved disposal facility for the permanent, environmentally safe disposition of vitrified immobilized low-activity waste (ILAW) packages that meets the environmental requirements and is approved by the U.S. Department of Energy (DOE) and Ecology. Low-activity waste is radioactive tank waste supernatant that has been treated to remove portions of certain radionuclides, principally cesium, strontium, and actinides.

- Conduct waste operations to receive and dispose of onsite and offsite generated mixed waste and low-level waste (in non-RCRA permitted cell). Low-level waste is radioactive waste that is not high-level radioactive waste, spent nuclear fuel, transuranic waste, byproduct material (as defined in Section 11e.(2) of the Atomic Energy Act of 1954), or naturally occurring radioactive material.

- Receive alternative waste forms (other than vitrified ILAW) from River Protection Project (RPP) tank operations and dispose of this waste onsite. Receive melters from RPP Waste Treatment Plant (RPP-WTP) that meet the IDF waste acceptance criteria and dispose of this waste.

A more detailed discussion of waste types and the identification of the processes and equipment are provided in Chapters 3.0 and 4.0 respectively. Pursuant to the Atomic Energy Act of 1954 (AEA), DOE has sole and exclusive responsibility and authority to regulate the source, special nuclear and by-product material component of radioactive mixed waste at DOE-owned nuclear facilities. Source, special nuclear and by-product materials, as defined by AEA, are not subject to regulation under RCRA or the Hazardous Waste Management Act, by the State of Washington and are not subject to State dangerous waste permit, orders, or any other enforceable instrument issued thereunder. DOE recognizes that radionuclide data may be useful in the development and confirmation of geohydrologic conceptual models . Radionuclide data contained herein is therefore provided as a matter of comity so the information may be used for such purposes.

In accordance with the Dangerous Waste Portion of the Resource Conservation And Recovery Act Permit for the Treatment, Storage, And Disposal Of Dangerous Waste At The Hanford Facility, a critical system is defined in the following manner:

> "The term "Critical Systems," as applied to determining whether a Permit Modification is required, means those specific portions of a TSD unit's structure, or equipment, whose failure could lead to the release of dangerous waste into the environment, and/or systems which include processes which treat, transfer, store, or dispose of regulated wastes....".

Critical systems for the IDF are defined as the liner system, leachate collection and removal system, and leak detection system, required by WAC 173-303-665(2)(h).

The IDF will not exist on tribal lands.

2.1 INTEGRATED DISPOSAL FACILITY DESCRIPTION [B-1]

The IDF will be constructed on 25 hectares of vacant land southwest of the PUREX Plant in the 200 East Area (Figure 2-1). The IDF will consist of a lined landfill, approximately 442 meters wide by 555 meters in length by up to 15 meters deep. The regulated portion of the landfill will be approximately 221 meters wide by 555 meters long by up to 15 meters deep. Containerized, self contained, and /or bulk waste will be accepted. The landfill is designed to accommodate four layers of vitrified ILAW waste containers separated vertically by 0.9-meters of soil. Alternative waste form sizes and landfill placement will be assessed when received at the IDF. The approximate total volume of waste to be disposed will be 900,000 cubic meters. The landfill will be segregated into a RCRA permitted side and a non-RCRA, non-permitted side. The scope of this permit application is limited to the western side of the landfill where the RCRA waste will be placed. The leachate collection system will be designed to segregate leachate collected from the individual sides. A high point down the center of the liner system will ensure the leachate from the RCRA permitted side does not contaminate the leachate from the non-RCRA side.

The IDF will include a secondary leak detection system (SLDS) consisting of operations layer type fill for a foundation of the LDS admix layer, drainage gravel with a hydraulic conductivity of at least 1×10^{-2} centimeter per second adjacent to a perforated pipe, a composite drainage net (CDN) and tertiary geomembrane. A nonwoven separation geotextile is located between the operations layer type material and the drainage gravel to minimize sediment (fine-soil) migration into the SLDS piping. The purpose of this system is to provide access to the area immediately below the LDS sump area. The SLDS will collect liquids resulting from construction water and potentially, liquid from other sources. The SLDS liners will convey collected liquids to the SLDS piping for monitoring and/or removal. The SLDS is not a design requirement of WAC 173-303-665, however DOE is adding the design feature pursuant to its authority under the Atomic Energy Act of 1954 (AEA) and not for the purposes of compliance with the dangerous waste regulations. Therefore information regarding the design, construction and operation of the secondary leak detection system is provided in this application as information only. Pursuant to AEA, DOE has sole and exclusive responsibility and authority to regulate the source, special nuclear and by-product material component of radioactive mixed waste at DOE-owned nuclear facilities. Source, special nuclear and by-product materials, as defined by AEA, are not subject to regulation under RCRA or the Hazardous Waste Management Act, by the State of Washington and are not be subject to State dangerous waste permit, orders, or any other enforceable instrument issued thereunder. DOE recognizes that radionuclide data may be useful in the development and confirmation of geohydrologic conceptual models. Radionuclide data contained herein is therefore provided as a matter of comity so the information may be used for such purposes.

The RCRA permitted side of the IDF will include a less than 90-day accumulation area for storage of leachate in a large tank for the Leachate Collection and Removal System (LCRS) and the Leak Detection System (LDS), and a smaller portable container for the Secondary Leak Detection System (SLDS). The leachate storage tanks will be located at the north end, in close proximity to the lined landfill. The tank will be protected by secondary containment. Leak detection of the tank will be provided by monitoring of the secondary containment. The collected leachate will be stored and sampled before transfer to an onsite TSD unit or offsite TSD facility. The less than 90-day leachate collection tank will be operated in accordance with the generator provisions of WAC 173-303-200 and WAC 173-303-640 as referenced by WAC 173-303-200. See Figure 2-5 for a simplified block diagram.

The landfill will be constructed in several phases. Starting at the northern edge, approximately one-third of the total length of the landfill will be constructed. This will include the leachate collection system and less than 90-day accumulation tanks. The subsequent phases will be constructed after waste has been placed in the landfill and the additional disposal capacity needed. This approach minimizes the open area susceptible to collection of rainwater and subsequent leachate. See Figure 2-4, IDF Sections of Construction Phases.

Before disposal, all waste will meet land disposal restriction (LDR) requirements [Revised Code of Washington (RCW) 70.105.050(2), WAC 173-303-140, and 40 Code of Federal Regulations (CFR) 268 incorporated by reference in WAC 173-303-140].

Future landfill construction and design within the IDF will be subject to change as disposal techniques improve or as waste management needs dictate. Additional IDF landfill development for mixed waste greater than the permitted size will be evaluated against WAC 173-303 requirements.

Waste stream compatibility (i.e., compatibility between individual waste streams and compatibility between waste streams and landfill design and construction parameters) will be assessed on a case by case basis. Criteria for assessing and determining waste stream compatibility will be identified in either the facility Waste Acceptance Criteria, Waste Analysis Plan, or other protocol or procedure as appropriate (refer to Chapter 3.0, Appendix 3A for further discussion of waste stream compatibility).

2.1.1 Other Environmental Permits

Environmental permits required to support operation of the IDF will be identified in the *Annual Hanford Site Environmental Permitting Status Report* (e.g., DOE/RL-96-63).

2.1.2 Construction Schedule

A construction schedule for the IDF is provided in Figure 2-2.

2.2 TOPOGRAPHIC MAP [B-2]

A topographic map reflecting general topographic requirements is located in Appendix 2A.The IDF is located on the Hanford Facility, which limits the use of surrounding land to Department of Energy activities. There are no surface waters in the area defined on the topographical map. Chapter 5 includes figures that reflect additional requirements for topographic maps. For the point of compliance and proposed groundwater wells see Figure 5-8, and for the aquifer location see Figure 5-4 and section 5.3 for the identification of the aquifer.

2.3 SEISMIC CONSIDERATION [B-3]

The IDF will be located in Zone 2B of the Uniform Building Code (UBC) as discussed in DOE/RL-91-28 (Chapter 4.0, Section 4.3.4.4.5). UBC Zone 2B seismic criteria parameters were used to demonstrate the buildings, tanks, and associated piping will withstand the maximum horizontal acceleration of a design earthquake. The landfill will meet Performance Category 3 hazard class (and associated earthquake loading), which is more stringent than Uniform Building Code Zone 2B criteria which was used to demonstrate the landfill will withstand the maximum horizontal acceleration requirement in a seismic event. Appendix 4A will provide additional design information demonstrating the design meets WAC 173-303-806(4).

No active faults, or evidence of a fault that has had a displacement during Holocene times, have been found on the Hanford Site (DOE/RL-91-28). The youngest faults recognized on the Hanford Site occur on Gable Mountain, over 4.5 kilometers north of the 200 East Area. These faults are Quaternary of age and are considered 'capable' (DOE/RL-91-28).

2.4 ROADWAY TRAFFIC INTO THE INTEGRATED DISPOSAL FACILITY [B-4]

General traffic information for the Hanford Facility is presented in the *Hanford Facility Dangerous Waste Permit Application, General Information Portion* (DOE/RL-91-28). Public access to the IDF will be restricted. Figure 2-3 depicts the normal transportation routes within the 200 East Area. Trucks will typically be used to transport waste to the IDF and range in size from heavy-duty pickup trucks to tractor-trailer rigs, depending on the size and weight of the load. In some cases, special equipment such as transporters are used for unusual or unique loads. When special equipment is used, an evaluation ensures that the equipment does not damage the roadways.

Approximately 120 personnel will traverse this roadway in personal vehicles in one shift per 24 hours per five days a week.

2.5 RELEASES FROM SOLID WASTE MANAGEMENT UNITS [E]

Information concerning releases from solid waste management units is discussed in the General Information Portion (DOE/RL-91-28 Appendix 2D). A groundwater monitoring program will be established as identified in Chapter 5.0.

ID	Task Name	Start	Finish
1	Detailed design (Critical Systems)	11/15/02	6/30/03
2	Detailed design (Non-Critical Systems)	7/1/03	2/27/04
3	Site Preparation (Non-Critical Systems)	4/15/04	9/30/04
4	IDF RCRA Part B Permit Approval	10/06/04	10/06/04
5	Construction (Critical Systems)	10/07/04	10/15/05
6	Cold Ops and Startup	10/16/05	2/28/06
7	M-90-10	8/31/08	8/31/08

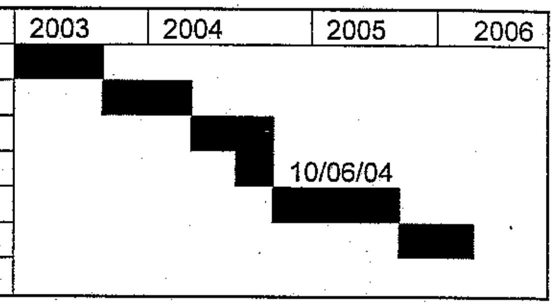

Figure 2-2. Construction Schedule for Integrated Disposal Facility (For information only).

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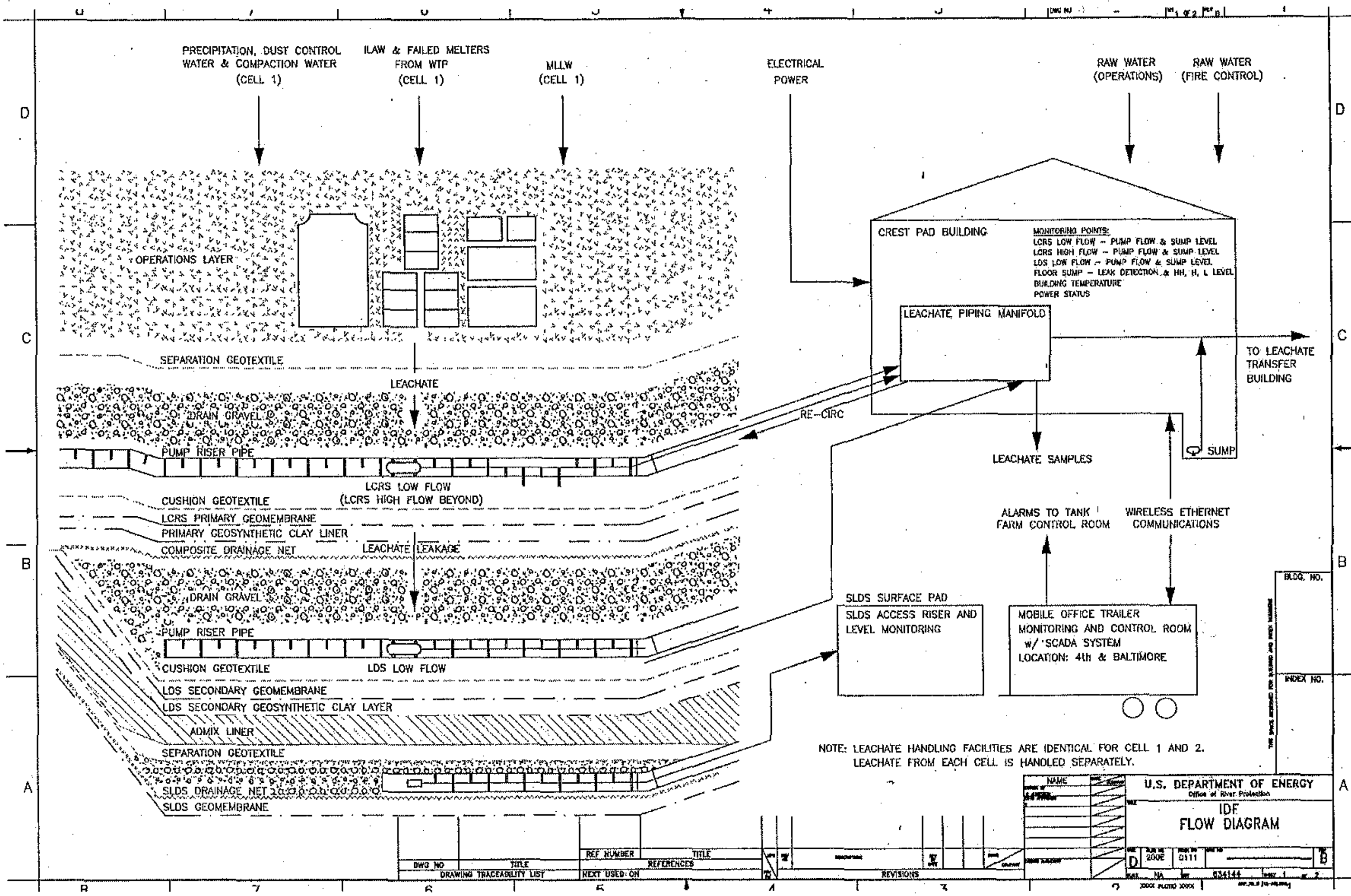

Figure 2-5. IDF Flow Diagram (Sheet 1).

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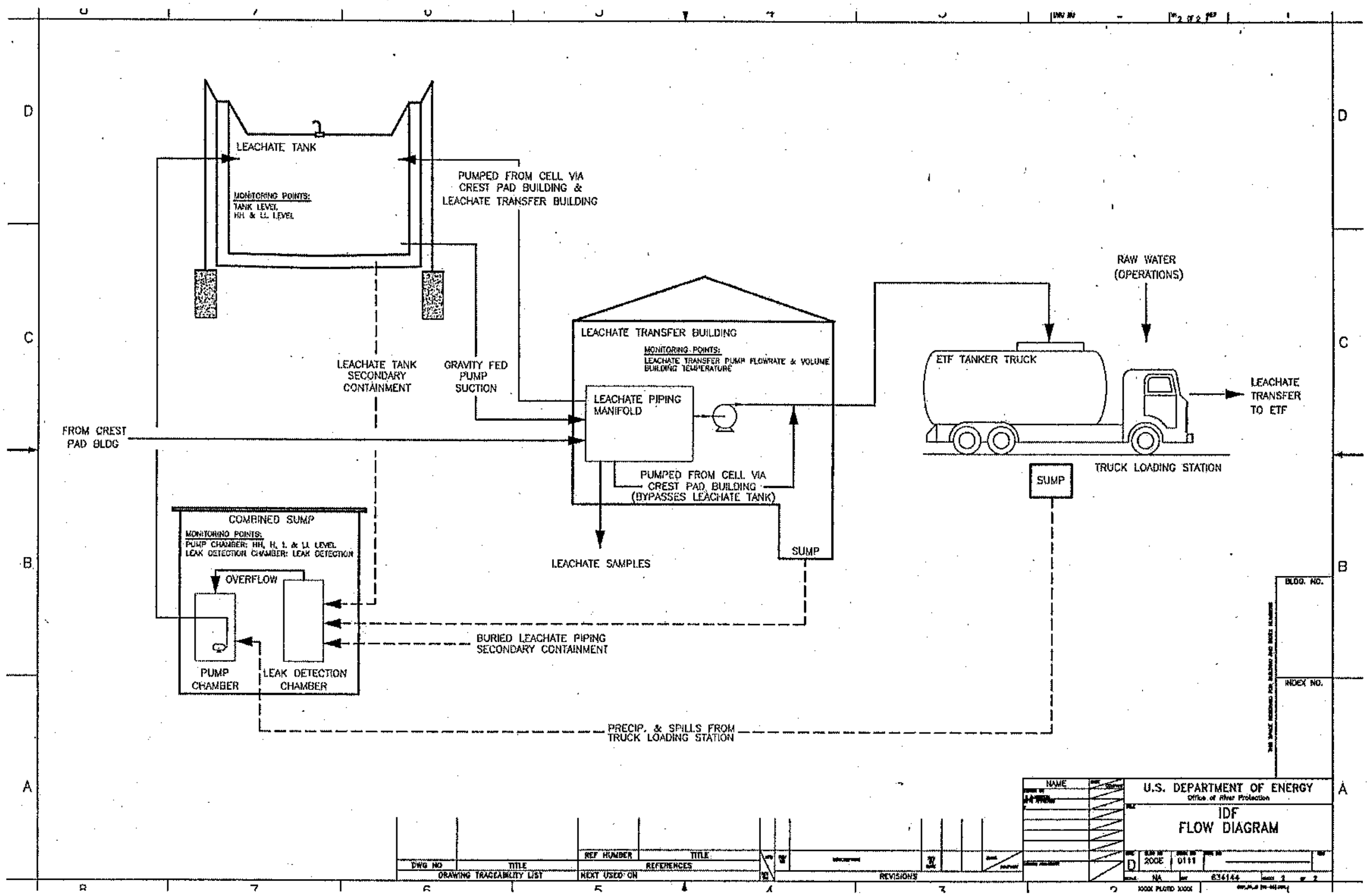

Figure 2-5. IDF Flow Diagram (Sheet 2).

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Figure 4-1. Integrated Disposal Facility Lined Landfill F4-1
Figure 4-2. Example of a Typical Liner. F4-2

4.0 PROCESS INFORMATION [D]

This chapter discusses the processes that will be used to dispose waste in the IDF and includes a discussion of the design and function of the following:

- Container
- Disposal landfill
- Leak detection system
- Leachate collection and removal system
- Secondary leak detection system (Note that the SLDS is not a design requirement of WAC 173-303-665, however DOE is adding the design feature pursuant to its authority under the Atomic Energy Act of 1954 (AEA) and not for the purposes of compliance with the dangerous waste regulations. Therefore information regarding the design, construction and operation of the secondary leak detection system is provided in this application as information only. Pursuant to AEA, DOE has sole and exclusive responsibility and authority to regulate the source, special nuclear and by-product material component of radioactive mixed waste at DOE-owned nuclear facilities. Source, special nuclear and by-product materials, as defined by AEA, are not subject to regulation under RCRA or the Hazardous Waste Management Act, by the State of Washington and are not be subject to State dangerous waste permit, orders, or any other enforceable instrument issued thereunder. DOE recognizes that radionuclide data may be useful in the development and confirmation of geohydrologic conceptual models. Radionuclide data contained herein is therefore provided as a matter of comity so the information may be used for such purposes).

Waste stream compatibility (i.e., compatibility between individual waste streams and compatibility between waste streams and landfill design and construction parameters) will be assessed on a case by case basis. Criteria for assessing and determining compatibility will be identified in either the facility Waste Acceptance Criteria, Waste Analysis Plan, or other protocol or procedure as appropriate (refer to Chapter 3.0, Appendix 3A for further discussion of waste stream compatibility).

Process Code S01 (container storage) has been included within this permit application, in the event that storage is required before final disposal (e.g., to support the confirmation process of the waste or cooling of vitrified waste if required). Waste failing the confirmation process (Chapter 3.0 Appendix 3A) will be identified as off-specification and may require storage prior to disposal. Only off-specification waste or vitrified waste requiring cooling (due to process heat) may be stored in the lined portion of the IDF pending disposition. To maintain operational flexibility, off-specification containers and vitrified waste requiring cooling could be left on the transport vehicles at the IDF until disposal can occur but may be off-loaded into the lined portion of the IDF pending final disposal provided the temperature administrative control limit is not exceeded. Off-specification waste and vitrified waste requiring cooling will be separated from other waste via tape, ropes, chains, or other cordon mechanism.

4.1 CONTAINERS [D-1]

All mixed waste accepted for disposal at the IDF will be packaged in standard containers [U.S. Department of Transportation (DOT) and/or DOE], unless alternate packages are dictated by the size, shape, or form of waste (49 CFR 173) (e.g., metal boxes), and self contained bulk waste.

4.1.1 Description of Containers [D-1a, D-1b, and D-1c]

Containers vary in shape, size, and strength depending on the form and weight of the waste. The most common containers are galvanized or aluminized 208-liter containers. Nominal 1.2-meter by 1.2-meter by 2.4-meter-steel boxes are used frequently. Waste disposed at the IDF will include vitrified immobilized low-activity waste (ILAW) from the RPP-WTP, mixed waste generated through waste operations, other low-level radioactive waste, offsite generated mixed and low-level waste, alternative ILAW forms, and failed low-activity waste and high-level waste melters.

The vitrified ILAW container is designed specifically for the vitrified ILAW waste form. Nominal vitrified ILAW container dimensions will be 122 centimeters base outside dimension, 107 centimeters top by 230 centimeters in length, with a wall thickness of 0.357 centimeter. The container volume will be 2.55 cubic meters. The vitrified ILAW containers will be fabricated from stainless steel sheet and plate. The vitrified ILAW will be compatible with the container. Before receipt at the IDF, vitrified ILAW containers will be closed at the RPP-WTP.

Due to the radioactivity and remote handling of the immobilized waste containers, conventional labeling of the vitrified immobilized waste containers will not be feasible and an alternative to the standard labeling requirements will be used. This alternative labeling approach will use a unique alphanumeric identifier that will be welded onto each immobilized glass waste container. The welded "identifier" will ensure that the number is always legible, will not be removed or damaged during container decontamination, will not be damaged by heat or radiation, and will not degrade over time.

The identifier will be welded onto the shoulder and side wall of each immobilized glass container at two locations 180 degrees apart. Characters will be approximately 2 in. high by 1.5 in. wide. The identifier will be formed by welding on stainless steel filler material at the time of container construction. This identifier will be used to track the container from receipt at the WTP, throughout its subsequent path at the WTP, shipment and disposal at the IDF to be disposed.

Each identifier will be composed of unique coded alphanumeric characters. This unique alphanumeric identification will be maintained within the plant information network, and will list data pertaining to the waste container including waste numbers, and the major risk(s) associated with the waste.

The container packaging and handling for the IDF are designed to maintain containment of the waste, limit storage intrusion, and limit human exposure to mixed waste. Unusual sized containers such as macro-encapsulated long-length contaminated equipment or ILAW packages will be handled by using cranes or other appropriate equipment.

On receipt, operations personnel will inspect each container to confirm appropriate documentation and compliance with the waste acceptance criteria before the container is placed in the IDF (refer to Chapter 3.0, Appendix 3A).

If containerized mixed waste must be opened (i.e., for confirmation sampling, repackaging, etc.), the container typically would be removed to an onsite treatment and/or storage unit or other approved location before being opened. The container would be sealed before being returned to the IDF.

4.2 LEACHATE COLLECTION TANKS

The aboveground leachate collection tank will support the lined IDF landfill. The leachate collection tank will be operated in accordance with the generator provisions of WAC 173-303-200 and WAC 173-303-640 as referenced by WAC 173-303-200.

For informational purposes, the following is provided for an understanding of the operation of the Leachate Collection Tank. Procedures will be written to manage the leachate in accordance with WAC 173-303-200. The presence of leachate in the tank will be detected with instrumentation within the two stilling wells. The level instrument within the first stilling well will monitor the depth of leachate in the tank. A second stilling well will have instrumentation for high-high and low-low alarm set-point trips. The leachate will be removed from the tank using a transfer pump.

4.3 LANDFILLS [D-6]

The following addresses the IDF lined landfill.

4.3.1 List of Wastes [D-6a]

IDF will receive mixed and/or dangerous waste.

Waste will be accepted as bulk and/or in containers (e.g. drums, boxes, larger containers, labpacks etc).

Waste streams acceptable at the IDF facility will fall within the range of dangerous waste numbers identified in the Part A form 3 (see chapter 1.0)

4.3.2 Liner System Exemption Requests [D-6b]

This permit application documentation does not seek an exemption to liner system requirements.

4.3.3 Liner System, General Items [D-6c]

This section provides a general description of the liner system to be used for the IDF lined landfill (Figure 4-1).

The liner system was designed to prevent migration of leachate out of the lined landfill during the active life of the landfill. The active life will consist of the operational period and the closure/postclosure period. The liner system was designed to meet U.S. Environmental Protection Agency (EPA) requirements, as identified in RCRA Subtitle C requirements for hazardous waste disposal facilities (40 CFR 264), technical guidance documents (e.g., EPA 1985), and WAC-173-303-665. In addition, the liner system will incorporate the following general functional requirements:

- Range of Operating Conditions--year-round operation, withstand construction, and long-term stresses

- Degree of Reliability--function safely and effectively throughout operating and closure/postclosure period with minimum maintenance

- Intended Life--operational phase plus closure/postclosure monitoring phase.

4.3.3.1 Liner System Description [D-6c(1)]

The landfill liner system will comply with WAC 173-303-665 requirements for dangerous waste landfills. Figure 4-2 shows a typical design and includes the following components (from top to bottom).

- Operations layer: minimum 0.9-meter thick of native soil. This layer will provide a working surface for equipment, protect the liner from mechanical damage, and prevent freezing of the underlying low-hydraulic conductivity soil layer. (Hydraulic conductivity is a measure of how rapidly a material can transmit water and is based on specific ASTM testing requirements.)

- Leachate collection and removal system (LCRS) will contain a minimum 0.3-meter-thick drainage gravel layer with a hydraulic conductivity of at least 1×10^{-2} centimeter per second (sometimes including perforated drainage pipes). A nonwoven separation geotextile is located between the operations layer and the drainage gravel layer to minimize sediment (fine-soil) migration into the LCRS. A nonwoven cushion geotextile is located between the drainage gravel and the primary geomembrane to protect the primary geomembrane.

The LCRS liners will collect and convey leachate to the LCRS sump for removal and will include the following components.

- Primary geomembrane liner: this liner will consist of high-density polyethylene (HDPE) because of its excellent resistance to expected chemicals (refer to Chapter 1.0); nominal 60-mil thickness (54-mil minimum), which is textured (to improve stability against sliding). The geomembrane will act as a moisture barrier. Located immediately above the primary geomembrane the LCRS will include a perforated pipe that helps collect and guide water into the leachate collection sump.' The perforated pipe is located along the centerline of the cell and provides high-flow path water to the primary collection sump.

- Primary geosynthetic clay liner (GCL): the GCL consisting of a high-swelling sodium synthetic mat containing bentonite with a hydraulic conductivity of 1×10^{-8} centimeter per second or less. This layer will act as an additional primary moisture barrier directly under the primary geomembrane.

The leak detection system (LDS) is similar to the LCRS except the composite drainage net (CDN) replaces the primary gravel layer, the geosynthetic clay liner (GCL) will be placed directly under the secondary geomembrane liner only under the LDS sump and the perforated pipes will not be needed because very high flow capacities will not be required. The purpose of this system will be to collect any leachate that leaks through the primary liner system and convey the leachate to the LDS sump for removal. The LDS also will serve as a secondary LCRS. The LDS liners will collect and convey leakage to the LDS sump and will include the following components:

- Secondary geomembrane liner: same as primary geomembrane liner.

- Secondary geosynthetic clay liner: same as primary geosynthetic clay liner.

- Admix liner: a minimum 0.9-meter-thick layer of compacted soil/bentonite admixture with a hydraulic conductivity of 1×10^{-7} centimeter per second or less. The bentonite will be high-swelling sodium bentonite. This layer will act as an additional moisture barrier directly under the secondary geosynthetic clay liner in the LDS sump area and the secondary geomembrane outside the LDS sump area.

- The secondary leak detection system (SLDS) consists of operations layer type fill for a foundation of the LDS admix layer, drainage gravel with a hydraulic conductivity of at least 1×10^{-2} centimeter per second adjacent to a perforated pipe, a composite drainage net (CDN) and tertiary geomembrane. A nonwoven separation geotextile is located between the operations layer type material and the drainage gravel to minimize sediment (fine-soil) migration into the SLDS piping. The purpose of this system is to provide access to the area immediately below the LDS sump area. The SLDS will collect liquids resulting from construction water and potentially, liquid from other sources. The SLDS liners will convey collected liquids to the SLDS piping for monitoring and/or removal. (Note that the secondary leak detection system is not a design requirement of WAC 173-303-665, however DOE is adding the design feature pursuant to its authority under the Atomic Energy Act of 1954 (AEA) and not for the purposes of compliance with the dangerous waste regulations. Therefore information regarding the design, construction and operation of the secondary leak detection system is provided in this application as information only. Pursuant to AEA, DOE has sole and exclusive responsibility and authority to regulate the source, special nuclear and by-product material component of radioactive mixed waste at DOE-owned nuclear facilities. Source, special nuclear and by-product materials, as defined by AEA, are not subject to regulation under RCRA or the Hazardous Waste Management Act, by the State of Washington and are not be subject to State dangerous waste permit, orders, or any other enforceable instrument issued thereunder. DOE recognizes that radionuclide data may be useful in the development and confirmation of geohydrologic conceptual models. Radionuclide data contained herein is therefore provided as a matter of comity so the information may be used for such purposes).

4.3.3.1.1 Operations Layer

The purpose of the operations layer will be to protect the underlying liner components from damage by equipment during lined landfill construction and operation. This layer also will protect the admix layer from freezing and desiccation cracking.

Previous research and experience has shown that desiccation cracks can occur under geomembrane liners when either the liner is not in close contact with the compacted admix or when the liner is subjected to wide temperature fluctuations (Corser and Cranston 1991). The operations layer will act as a weight to keep the geomembrane in contact with the admix, thereby reducing the potential for water vapor to form in an underlying airspace. The operations layer also will act as an insulating layer, together with the dead air space trapped in the underlying drainage layers.

The operations layer material typically will consist of onsite granular soil that is reasonably well graded. The material will have a maximum particle size limit of 5.1 centimeters or less, to facilitate protection of the underlying layers.

4.3.3.1.2 Leachate Collection and Removal System

The LCRS will be located below the operations layer and will provide a flow path for the leachate flowing into the LCRS sump. Between the operations layer and the underlying drainage gravel, a geotextile layer will function as a filter separation barrier. The geotextile will prevent migration of fine soil and clogging of the drainage gravel. On the lined landfill floor the drain gravel will be a minimum 0.3-meter-thick layer of washed, rounded to subrounded stone, with a hydraulic conductivity of at least 1×10^{-2} centimeter per second. In addition, a perforated high-density polyethylene drainage pipe will be placed within the drainage gravel to accelerate leachate transport into the LCRS sump during high precipitation events. On the lined landfill floor the drain gravel layer will be underlain by a geotextile cushion resting on the primary high-density polyethylene geomembrane. The geotextile will provide additional protection for the primary geomembrane on the floor of the landfill.

On the lined landfill sideslopes, the LCRS will have a composite drainage net (CDN) layer composed of a geonet (which is a network of HDPE strands, interwoven and bonded to form a panel that provides a drainage pathway for fluids), with a layer of geotextile thermally bonded to each side. This CDN layer will have a transmissivity of at least 3×10^{-5} meters squared per second. The CDN will be used on the sideslopes to avoid problems associated with placement of clean granular material on slopes, thereby minimizing the potential for damaging the underlying liner system.

4.3.3.1.3 Primary Geomembrane Liner

The primary geomembrane liner will act both as an impermeable leachate barrier and as a flow surface, routing leachate to the primary sump. High-density polyethylene will be used because of its high resistance to chemical deterioration. Generally, textured (roughened) geomembrane will be used to maximize shear strength along adjacent interfaces and to reduce the potential for sliding of the liner system.

4.3.3.1.4 Primary Geosynthetic Clay Liner Layer

A primary geosynthetic clay liner (GCL) will consist of a mat of bentonite placed between two geotextiles. The GCL will be installed immediately beneath the primary high-density polyethylene liner on the floor of the lined landfill only. The purpose of this liner will be to provide extra protection in the case of deterioration (such as stress cracking) of the primary geomembrane where operations will continue for several years.

The in-place hydraulic conductivity of the GCL will be 1 x 10^{-8} centimeter per second or less, exceeding the WAC hydraulic conductivity requirement for the secondary soil liners. The upper surface of GCL provides a smooth uniform surface on which to place the overlying geomembrane liner.

4.3.3.1.5 Leak Detection System

The LDS will provide the flow path for leachate flowing into the LDS sump. The following is a description of the system to be used in the IDF landfill.

The LDS will have a CDN drainage layer on the floor, and a CDN drainage layer on the sideslopes. The CDN consist of a layer of geotextile thermally bonded to each side of the geonet. These materials and their configuration will be similar to the LCRS described in Section 4.3.3.1.2, except for the absence of a drainage gravel layer and a perforated drainage pipe system on the floor of the lined landfill. The LDS will channel leachate that penetrates the primary liner system through the CDN into the leak detection sump.

The LDS serves as a secondary LCRS for the IDF. Leachate collected in the secondary sump will be measured to determine the leakage rate through the primary liner.

4.3.3.1.6 Secondary and Tertiary Geomembrane Liner

The secondary geomembrane liner, located underneath the LDS, will be placed directly against the secondary compacted admix liner, except in the LDS sump area which will include a geosynthetic clay liner between the secondary geomembrane liner and the secondary compacted admix liner. For information only, the teriary geomembrane liner for the SLDS will be placed directly against subgrade as per 4.3.3.1.8. The secondary and teriary geomembrane liners will be similar to the primary geomembrane described in Section 4.3.3.1.3. The secondary geosynthetic clay liner material will be similar to the primary geosynthetic clay liner described in Section 4.3.3.1.4.

4.3.3.1.7 Secondary Admix Liner

The secondary admix liner will have a minimum 0.9-meter-thick compacted soil/bentonite admixture located immediately beneath the secondary high-density polyethylene liner, as required by WAC 173-303-665. The secondary admix liner typically will consist of silty sand from local borrow sources mixed with a nominal 12 percent sodium bentonite, by dry weight. The in-place hydraulic conductivity of the admix liner will be 1 x 10^{-7} centimeter per second or less, consistent with WAC requirements for secondary soil liners. The upper surface of the secondary admix liner will be trimmed to the design grades and tolerances. The surface will be rolled with a smooth steel-drum roller to remove all ridges and irregularities. The result will be a smooth uniform surface on which to place the overlying geomembrane liner.

4.3.3.1.8 Subgrade/Liner System Foundation

The lined landfill in the IDF will be founded in undisturbed native soils or material compacted to at least 95 %of a standard proctor maximum density (determined by ASTM D698). The liner system foundation is discussed in further detail in Section 4.3.4.

4.3.3.1.9 Access Ramp

The lined landfill will have an access ramp outside the lined portion of the landfill, minimizing damage to the liner system from vehicle traffic into the lined landfill. As the landfill expands the access ramp will be reconstructed to the south of each expansion in the landfill. The access ramp design could vary as the landfill expands.

4.3.3.1.10 Landfill Expansion

The initial phase of the IDF liner will be complete at the north end of the landfill. As shown in Figure 4-1, construction of the first IDF phase will complete the liner system on the north sideslope and the excavated portions of the landfill floor, east sideslope, and west sideslope. The dashed line of Figure 4-1 across the south edge of the landfill floor denotes the southern extent of the landfill liner. The liner system will be installed to extend approximately 15 meters beyond the estimated toe of slope of the first phase waste placement. This extension will also allow waste haul vehicles to be staged or unloaded over a lined area. Termination detail for the south edge of the liner system is found in Appendix 4A on drawing H-2-830840. The south sideslope of the first phase of IDF is not lined to allow future expansion of the IDF. At the south end of the cells will be a storm water berm/ditch with an infiltration area, which will capture clean runoff from the unlined south sideslope before it runs onto the lined landfill. The landfill floor slopes up 1% from north to south to allow adequate leachate collection capacity for a 25 year storm event. Each future liner construction project will connect to the south edge of the previously constructed liner and operations systems and extend the disposal area further to the south. With the expansion of the IDF in subsequent phases, access ramps for the previous phase will be destroyed and new ramps built on the south edge of the landfill.

4.3.3.2 Liner System Location Relative to High Water Table [D-6c(2)]

The water table is located approximately 90 to 100 meters below the ground surface in the IDF. It is anticipated that the deepest point of the liner system will be no greater than 20 meters below ground surface. Consequently, the liner systems will be at least 69 meters above groundwater. The liner systems will not be affected by the water table because of this large elevational difference.

4.3.3.3 Loads on Liner System [D-6c(3)]

The liner system will experience several types of stresses during construction, operation, and closure/postclosure periods. The following sections discuss the types of stress and analytical methods used to design the IDF liners.

4.3.3.3.1 Liner Stress

The geosynthetic liner components will experience some stress particularly during installation and before placing waste in the lined landfill but also during the entire lifecycle. The high-density polyethylene liner will be temperature sensitive, expanding and contracting as liner temperatures increase and decrease. Thermally induced stresses could develop in the liner if deployment and anchoring occur just before a significant decrease in the liner temperature. The operations layer will be sufficiently thick to ensure liner stress remains below the yield strain and stress. Administrative procedures will prevent loading and backfilling of waste exceeding applicable thermal limits due to recent vitrification processes to avoid potential liner damage.

The drainage gravel will have the potential to produce localized stress on the geomembrane liner during gravel placement with construction equipment. A geotextile cushion will be placed at the base of the drainage gravel to protect the underlying geomembrane. A puncture analysis was performed to select a sufficiently thick cushion geotextile. This analysis incorporated expected construction vehicle ground pressures and design drainage gravel gradation listed in the construction specifications. If required, engineering controls such as independent foundations will be installed to minimize liner stress involved with melter and/or other large package disposal.

On the landfill sideslopes, tension induced by liner-component load transfer is not anticipated, because the liner interface effective shear strength angles will be higher than the sideslope angles. The liner component interface strengths were determined by laboratory direct shear tests. Both static and dynamic stability analyses were performed, using standard methods, design accelerations, and factors of safety.

Stress on the geomembrane in the anchor trench also were evaluated during detailed design. Wind uplift and thermal expansion and contraction could cause stress in the geomembrane during construction. However, these stresses will not be a problem, because the stress will be relatively low as compared to the tensile strength of the liner. In addition, these stresses are minimized by using sand bags to control liner position during liner panel placement and welding, as well as keeping the anchor trench open until the liner is stabilized with overlaying fill material. Placement of overlaying fill material is controlled to limit stress buildup in the liner. The stress will not be present after construction, because of the weight and insulating properties of the operations layer.

4.3.3.3.2 Stress Resulting From Operating Equipment

Operations equipment provides a design load case on the IDF liner, which was analyzed as part of the IDF design (refer to Appendix 4-A). The analyses show that the 0.9-meter-thick operations layer will dissipate stress produced by the operating equipment and is sufficient to protect the IDF liner system.

4.3.3.3.3 Stress From Maximum Quantity of Waste, Cover, and Proposed Closure/Postclosure Land Use

When the lined landfill is full and the cover system is in place, the liner system will experience a static load from the overlying waste, backfill, and cover materials. No significant increase in stresses on the liner system is anticipated from closure/postclosure land use. The maximum design load of material overlying the liner system includes an allowance for the cover system. Analyses include puncture protection of the geomembrane by the cushion geotextile, and decrease in transmissivity of CDN drainage layers. Materials were specified based on the ability of the materials to perform adequately under closure/postclosure loading conditions.

Dynamic stress on the liner system will result primarily from ground accelerations during seismic events. Both static and dynamic analyses were performed on the subgrade and liner components based on the finished configuration of the empty landfill. Under closure/postclosure conditions, the waste, backfill, and cover materials will tend to buttress the liner system, resulting in greater stability relative to the operational phase. All of the analyses verified adequate stability for the IDF.

4.3.3.3.4 Stresses Resulting From Settlement, Subsidence, or Uplift

The subgrade settlement produced by waste loading essentially will be elastic because of the coarse-grained, noncohesive, and drained nature of the soil. The subgrade will rebound during the excavation phase of construction and will settle as the landfill is filled. The compacted admix liner will consolidate under waste loads. The total settlement will be a combination of the subgrade elastic and the admix consolidation settlements. These settlements were analyzed with standard methods during detailed design of the lined landfill. In general, differential settlements will be expected to occur primarily across the lined landfill sideslopes as the thickness of waste decreases from maximum to zero. The geosynthetic liner components were analyzed, the anticipated strains likely will not produce any appreciable stresses in the liner system.

The potential for subsidence-induced stress is believed to be negligible based on the following information:

- The soils underlying the IDF tend to be coarse-grained soils, sands and gravels, in a relatively dense configuration that will not be subject to piping effects that could transport soil resulting in subsidence.

- The groundwater level will be deep, at least 69.6 meters below the base of the lined landfill, and will not affect bearing soils.

- No natural voids, or man-made mining or tunneling has been noted. If the groundwater level was lowered substantially and consolidation occurred in the aquifer, local site-specific subsidence would be negligible because of the depth of the groundwater below the lined landfill.

The potential for stresses resulting from uplift on the liner system also is expected to be negligible. The seasonal groundwater level is very deep, and higher-elevation perched groundwater likely will not develop because of the absence of aquitards in the coarse-grained Hanford formation underlying the IDF. The coarse-grained nature of the Hanford formation also promotes rapid, primarily vertical, infiltration, which means it is unlikely that infiltration from outside the lined landfill boundary would be transported laterally underneath the landfill liner. Gas pressures similarly are unlikely to develop because of the absence of any organic material that could generate significant subsurface gas (from organic material decomposition) and the coarse-grained, highly permeable sands and gravels underlying the landfill.

4.3.3.3.5 Internal and External Pressure Gradients

Pressure gradients across the liner caused by liquids or gases will be expected to be negligible. Internal pressures due to liquids will be controlled by the leachate collection and removal system. Because leachate will be removed from the flat 50-foot by 50-foot LCRS sump in a timely manner, there will be minimal liquid head on the liner (less than 30.5 centimeters according to WAC regulations). Gas generated internally is expected to be minimal because waste is inorganic and non-reactive. However any pre-closure internally generated gas will be vented either through the waste or the leachate collection system. The closure cover design will consider gas venting.

External pressures on the liner system will be expected to be minimal. Gas pressures will be negligible because the subgrade soil contains no gas producing materials and is highly permeable, readily venting any potential gas to the atmosphere. External pressure from liquids will not be anticipated because of the deep groundwater table and the highly permeable foundation soils.

4.3.3.4 Liner System Coverage [D-6c(4)]

The liner system will cover all soils underlying the lined landfill and extends over the crest of the sideslopes into the anchor trench (Figure 4-2, Detail 3).

4.3.3.5 Liner System Exposure Prevention [D-6c(5)]

No geosynthetic or admix components of the liner system will be exposed to the atmosphere. The minimum 0.9-meter-thick operations layer will cover the entire lined landfill surface. This layer will serve both as a physical protective barrier and as thermal insulation, protecting the admix layer from desiccation and frost damage.

Excessive erosion, such as gullying, will be repaired by replacing the eroded soil. Dust suppression agents will be used to prevent excessive wind erosion on the landfill sideslopes. The dust suppression agents will bind the surface of the operations layer and will minimize wind entrainment of soil.

4.3.4 Liner System, Foundation [D-6d]

The following sections discuss the foundations beneath the liner systems.

4.3.4.1 Foundation Description [D-6d(1)]

At the IDF, the Hanford formation consists mainly of sand dominated facies with lesser amounts of silt dominated and gravel dominated facies. Where sands are present, these sands are underlain by the Hanford formation. Here, the Hanford formation has been described as poorly sorted pebble to boulder gravel and fine to course grained sand, with lesser amounts of interstitial and interbedded silt and clay.

The two geologic units pertinent to the IDF lined landfill are summarized as follows.

Recent eolian sand: The sand is light olive gray in color and has a density that is loose at the surface but becomes compact with depth. The sand has a fine to medium grain size and includes little to some nonplastic silt-sized fines. The deposit is homogeneous except for a distinguishable layer of volcanic ash in some locations.

Glaciofluvial flood deposit: This deposit has well graded mixtures of sands and gravels with trace to little nonplastic silt-sized particles. The gravel content can vary with depth, and the deposit can become predominantly gravel. This coarse-grained deposit is part of the Cold Creek Bar, which was formed during the Pleistocene Epoch by glacial outburst flooding.

4.3.4.2 Subsurface Exploration Data [D-6d(2)]

Geological site investigations were used to support the detailed design of the landfill. The investigations consisted of a review of historical data, including well logs (Chapter 5.0), exploratory borings, and surface pit samples data. Because the foundation soils are relatively consistent over broad areas, the need for additional borings and geophysical investigations will be determined on a case-by-case basis. If boreholes are drilled, penetration test data will be collected to determine the strength of the foundation materials in situ.

4.3.4.3 Laboratory Testing Data [D-6d(3)]

Laboratory testing will be performed on the surface soil samples and borings, both from the lined landfill site and from potential borrow source locations as follows. Testing will be performed to classify soils, provide input parameters to verify engineering analyses, and for preparing material and construction specifications. The following tests will be performed on the soil samples:

- Visual classification (ASTM D2487)--to classify soils
- Natural moisture content (ASTM D2216)--for input to engineering analyses and preparing construction specifications
- Particle size analysis (ASTM D422 or D1140/C136)--for classification and input to engineering analyses
- Moisture-density relationships (ASTM D698 or D1557)--for preparing compaction specifications

Laboratory testing will be performed according to the most recent versions of ASTM methods or other recognized standards. Additional tests will be performed as needed.

4.3.4.4 Engineering Analyses [D-6d(4)]

The subgrade will be required to support the liner system and overlying materials (waste, fill, and cover) without excessive settlement, compression, or uplift that could damage the liner system. This section describes the design approach used to satisfy these criteria.

4.3.4.4.1 Settlement Potential [D-6d(4)(a)]

The subgrade settlement produced by waste loading essentially will be elastic because of the coarse-grained, noncohesive, and drained nature of the soil. The subgrade will rebound during the excavation phase of construction and will settle as the landfill is filled. An elastic settlement analysis using standard methods was performed and results indicate the magnitude of the total and differential settlement is within performance limits.

4.3.4.4.2 Bearing Capacity [D-6d(4)(b)]

The bearing capacity of the subgrade soil will need to support structures such as leachate collection tanks. The construction specifications typically will require that the upper portion of the subgrade soil and all structural fill be moisture conditioned and compacted to at least 95 percent of the maximum standard Proctor dry density (ASTM D698). Maximum allowable bearing capacities for foundations have been established using standard geotechnical methods. Bearing capacities for the types of soils expected at the IDF typically are greater than the maximum expected loads from the support structures.

4.3.4.4.3 Stability of Lined Landfill Slopes [D-6d(4)(c)]

The lined landfill will be constructed in eolian sand and the underlying coarse-grained Hanford formation. In granular, cohesionless, and drained soils such as these, the stability of the slope will be related primarily to the maximum slope angle. Both veneer and global stability analyses were performed to determine both static and dynamic sideslope stability. Results demonstrate adequate stability for the IDF throughout its design life.

4.3.4.4.4 Potential for Excess Hydrostatic or Gas Pressures [D-6d(4)(d)]

Because the seasonal high-water level is at least 69 meters below the base of the deepest lined landfill, no external hydrostatic pressure will be expected from this source. Because of the coarse-grained nature of the foundation soils, any infiltration of surface water around the perimeter of the lined landfill will be expected to travel primarily downward. Therefore, infiltration should not cause substantial pressure on the exterior of the liner system. Internal hydrostatic pressure from leachate will be negligible because the leachate will be removed from the lined landfill to limit head on the liner.

Gas pressure exerted externally on the liner system is expected to be negligible, because no gas-generating material (i.e., organic material) is expected in the foundation soils. If any gas were generated below the liner system, little pressure buildup would occur because of the unsaturated coarse-grained nature of the foundation soils, which would vent the gas to the atmosphere. Internal gas pressure buildup will not be anticipated, because wastes are generally inorganic and have low gas generating potential, and the leachate collection system will be vented to the atmosphere and dissipates any gas.

4.3.4.4.5 Seismic Conditions

Potential hazards from seismic events will include faulting, slope failure, and liquefaction. Disruption of the lined landfill by faulting is not considered a significant risk because (1) no major faults have been identified at the IDF (DOE/RW-0164) and (2) only one central fault at Gable Mountain on the Hanford Site shows evidence of movement within the last 13,000 years. The potential for slope failure is considered low, because granular materials typically have high strengths relative to the maximum sideslope angles expected for the lined landfill. Liquefaction will occur in loose, poorly graded granular materials that are subjected to shaking from seismic events. Saturated soils will be most susceptible because of high dynamic pore pressures that temporarily lower the effective stress. During this process, the soil particles will be rearranged into a more dense configuration, with a resulting decrease in volume. The foundation materials at the IDF is not considered susceptible to liquefaction because the materials are well graded granular soils that are unsaturated and relatively dense.

The IDF support building (not sited within the TSD boundary) will be located in Zone 2B as identified in the Uniform Building Code (ICBO 1997).

4.3.4.4.6 Subsidence Potential

In general, subsidence of undisturbed foundation materials would be the result of dissolution, fluid extraction (water or petroleum), or mining. The potential for subsidence will be negligible at the IDF based on the following.

- The soils underlying the IDF are coarse-grained sands and gravels, in a relatively dense configuration which are not subject to piping that can cause transport of soil and resulting subsidence.

- The groundwater level is deep, at least 69 meters below the base of the lined landfill, and does not affect bearing soils.

- The soil and rock types below the IDF are not soluble.

- No mining or tunneling has been noted. If the groundwater level was lowered substantially and consolidation occurred in the aquifer, local site-specific subsidence would be negligible because of the depth of the groundwater table below the lined landfill.

4.3.4.4.7 Sinkhole Potential

Borings in and around the IDF have not identified any soluble materials in the foundation soils or underlying sediments. Consequently, the potential for any sinkhole development is negligible.

4.3.5 Liner System, Liners [D-6e]

The following sections discuss the individual components of the IDF liner systems.

4.3.5.1 Synthetic Liners [D-6e(1)]

As described in Section 4.3.3, the synthetic liners will act as an impermeable barrier for leachate migration (Figure 4-2). The synthetic liners will consist of high-density polyethylene material that will make the liners resistant to chemical deterioration. Section 4.3.3 describes the synthetic liner system in greater detail.

4.3.5.2 Synthetic Liner Compatibility Data [D-6e(1)(a)]

During detailed design of the lined landfill, the composition of the expected leachate was estimated. Expected leachate composition was based on known waste composition, process information, leachate from other operating lined landfills, and similar sources of data. Leachate constituents were compared to manufacturers' chemical compatibility data for synthetic liner components. In addition, the results of previous chemical compatibility testing and studies were evaluated against leachate composition. Information gained from this evaluation was used to select a liner that will be compatible with the expected leachate.
Compatibility testing for leachate tank liner material is planned for construction. An immersion test program is included in the technical specifications for the tank liner (anticipated to be XR-5 material). The immersion testing program will require the construction general contractor to submit tank liner samples to the design engineer for immersion testing as part of the submittal and certification process for the tank. Immersion testing will follow EPA 9090A (and ASTM) test protocols.

During landfill operation, the compatibility of waste receipts with the liner will be ensured. The compatibility of the waste constituents with the liner material will be established by laboratory testing if determined to be necessary, based on waste type and concentrations. Such tests will follow EPA Method 9090A or other appropriate methods. Test results will be evaluated using statistical methods and accepted criteria (based on past projects and agency acceptance) for liner/leachate compatibility.

4.3.5.3 Synthetic Liner Strength [D-6e(1)(b)]

As discussed in Section 4.3.3.3, the liner system will experience loads from several sources. During the detailed design process for the landfill, the strength of liner system materials was evaluated against these loads. The analysis indicated an adequate factor of safety for liner system materials.

Seams in geomembranes will be a critical area. However, with correct installation methods, the seams will be stronger than the surrounding material. Detailed installation and testing requirements will be included in the construction quality assurance plan (Section 4.3.7.3) to ensure that the liner is constructed properly. In addition, methods will be established to demonstrate adequate seam strength is achieved during installation.

Seaming requirements for the geotextilesand CDN will not be as stringent. These materials will be overlapped sufficiently to provide complete area coverage, and relatively light seams will be used to hold the panels in position during construction. After the lining system has been completed, seam strength requirements for these materials will be negligible.

4.3.5.4 Synthetic Liner Bedding [D-6e(1)(c)]

The primary geomembrane liner will be in contact with the GCLand geotextile cushion underlying the drainage gravel.

The secondary geomembrane liner will be in direct contact with the compacted admix layer. This type of subgrade is typical for flexible geomembrane liners. No problems related to the mechanical integrity of the geomembrane liner will be expected in this application.

With respect to the drainage gravel and operations layers, the geomembranes will be protected by overlying geotextile cushion or CDN layers. These geotextiles were designed to provide adequate protection during construction and operation to withstand the loads discussed in Section 4.3.3.3.

4.3.5.5 Soil Liners [D-6e(2)]

The IDF landfill will be lined with a minimum (0.9-meter thick) layer of compacted soil/bentonite mixture (admix) under the secondary geomembrane liner. This layer will have an in-place hydraulic conductivity of less than 1×10^{-7} centimeter per second. The soil component of the admix will be silty fine sand or similar material from areas near the IDF. Approximately 12 percent bentonite by dry weight will be added to the fine soil to achieve sufficiently low hydraulic conductivity; however, the percent might vary. Construction of the liner is discussed in Section 4.3.7.

4.3.5.5.1 Material Testing Data [D-6e(2)(a)]

Laboratory testing will be performed on soil liner materials to confirm input parameters for engineering analyses and for refining material and construction specifications.

Before constructing the lined landfill, a full-scale test fill of the admix material will be conducted. The primary purpose of the test fill will be to verify that the specified soil density, moisture content, and hydraulic conductivity values will be achieved consistently using proposed compaction equipment and procedures. In-place density will be measured using both the nuclear gauge (ASTM D2922) and sand cone (ASTM D1556) methods. In-place hydraulic conductivity will be determined from a two stage infiltration from a borehole (ASTM D6391). Admix hydraulic conductivity will be estimated from thin-wall tube samples (ASTM D1587) obtained from the test fill and tested in the laboratory (ASTM D5084). Details of the test fill are presented in the Construction Quality Assurance Plan (Appendix 4B). During construction, field density (e.g., ASTM D2922, D2167, and/or D1556) and moisture content (ASTM D2216) will be measured periodically. Thin-wall tube samples (ASTM D1587) will be taken at regular intervals and will be tested for hydraulic conductivity (ASTM D5084). Additional details of field testing during construction will be presented in the Construction Quality Assurance Plan.

Dispersion and piping in the admix are not considered likely because the hydraulic conductivity, and thus the flow velocity, will be very low, making it difficult to move the soil particles or otherwise disrupt the soil fabric. In addition, the admix will be well graded, so the component particles will tend to hold each other in place. Therefore, testing for these characteristics will not be necessary.

4.3.5.5.2 Soil Liner Compatibility Data [D-6e(2)(b)]

As discussed in Section 4.3.5.2, expected leachate composition was determined as part of detailed landfill design. The results of previous chemical compatibility testing and studies were evaluated against leachate composition to determine the effect of leachate on soil liner composition or hydraulic conductivity. The tests followed the procedures of ASTM D5084 (flexible wall parameter) and considered the effects of radiation on the soil liner materials.

4.3.5.5.3 Soil Liner Thickness [D-6e(2)(c)]

The IDF has been designed and will be operated to minimize the leachate head over the liner systems. Design of the primary liner system has included an additional clay layer (the primary GCL layer, which was previously described in Section 4.3.3.1) underlying the primary HDPE geomembrane to further minimize liner leakage from the primary liner. Note that only a single geomembrane is required under WAC 173-303 for the primary liner.

Calculations were performed to evaluate the effectiveness of the primary soil liner as a barrier to leachate. Leakage analyses were performed for the primary liner system using EPA's Hydrologic Evaluation of Landfill Performance (HELP) Model (Schroeder et al. 1997). Estimated leakage rates were compared to the Action Leakage Rate (ALR, which is defined in WAC 173-303-665[8] as "the maximum design flow rate that the leak detection system … can remove without the fluid head on the bottom liner exceeding 1 foot"), and were determined to be much lower than the ALR. This demonstrates the benefit of the GCL included in the primary bottom lining system, which provides a composite lining system and minimizes actual leakage through the bottom primary lining system.

Overall, the IDF is designed to actively convey and collect leachate from the liner areas of the facility to minimize leachate buildup over the liners. Leachate is conveyed to the LCRS and LDS sumps for active removal from the facility. In addition, the LCRS sump area has been designed with a 6-inch-deep sump trough where the LCRS pumps are positioned to minimize the area of the sump that has a permanent liquid level (below the pump intake/shutoff elevation). Both the LCRS and LDS sump pumps will be operated throughout the active life of the facility and into the post-closure time period until leachate generation has essentially ceased. By actively removing leachate from the IDF, head buildup is minimized, which in turn minimizes leakage through both the primary and secondary liner systems.

4.3.5.5.4 Soil Liner Strength [D-6e(2)(d)]

The expected loads on the liner system are discussed in Section 4.3.3.3. Significant stresses in the soil liner that were considered include (1) stresses from the weight of the liner system, (2) stresses on the interface with the overlying materials, and (3) stresses during construction.

Stresses will be present on the sideslopes from the weight of the operations layer and soil liner itself. Using material properties determined from laboratory testing, the stability of the soil liner were evaluated under both static and dynamic loading conditions. Standard methods of slope stability analysis were used. Interface strengths were found to provide adequate veneer stability for the liner system. Interface strength is the shear strength that occurs between layers of liner materials at their interface boundary, as established by ASTM test methods.

The primary concern during construction will be bearing failure caused by the weight of overlying soil components of the liner system (e.g., drainage gravel on the floor) and the construction equipment used to spread these materials. Strength parameters developed from laboratory testing and standard analytical methods were again used to determine that adequate stability and bearing capacity exist for the IDF liner system.

4.3.5.5.5 Engineering Report [D-6e(2)(e)]

An engineering report was prepared for the lined landfill as part of the definitive design document package. The report describes the design of the liner system and includes supporting calculations. The critical systems IDF Design Report is provided in Appendix 4A. The final IDF design report was prepared under the supervision of a professional engineer registered in Washington State.

4.3.6 Liner System, Leachate Collection and Removal System [D-6f]

The purpose of the leachate collection and removal system will be to provide sufficient hydraulic conductivity and storage volume to collect, retain, and dispose of, in a timely manner, fluids falling on or moving through the waste. The primary leachate collection and removal system will provide the preferential path along which the leachate will flow into the primary sump. The secondary leachate collection and removal system (also called the leak detection system) will be located between the primary and secondary geomembranes. The secondary leachate collection and removal system will provide the preferential path along which any fluids leaking through the primary liner system flow to the secondary sump.

The collected leachate will be pumped to a leachate collection tank, screened and/or sampled, and transferred to a permitted treatment and disposal unit.

4.3.6.1 System Operation and Design [D-6f(1)]

The lined landfill will be operated in a way that ensures the bottom liner is maintained as dry as possible, and the head on the top liner does not exceed 30.5 centimeters measured above the flat 50-foot by 50-foot LCRS sump HDPE liner. In extreme conditions (i.e., in excess of a 25-year storm event), the head on the top liner could exceed 30.5 centimeters for short durations. The operating methodology, described in the following paragraphs, will ensure that liquids on the bottom liner are removed continuously before liquids could accumulate and exceed 30.5 centimeters for the design storm event.

Both leachate collection systems either will be operated manually or automatically. When operated automatically, liquid level sensors will cycle the pumps on and off, in response to rising and falling leachate levels. The leakage rate through the top liner will be calculated to demonstrate that the leakage rate is less than the 'action leakage rate'. Data to support the leakage rate calculations will be obtained either from the flow totalizer in the secondary leachate collection pump discharge line or from the liquid level gauges. Collected leachate from the secondary leachate collection system will be pumped to the leachate collection tank (preferred option) or back to the primary leachate collection system.

The design of the primary and secondary leachate collection systems is described in Section 4.3.3.1. System geometry was completed and material specifications were developed during the detailed design process. The leachate collection and removal system design will comply with WAC 173-303 requirements and applicable guidance.

Each sump will have a thick layer of gravel designed to provide high hydraulic conductivity and storage capacity. Leachate will be removed from the sumps by a pump installed in sideslope riser pipes. Pressure transducers will be used to monitor leachate level in the sumps and will provide appropriate signals to the pump control system. All pumps and transducers will be removable for maintenance, calibration, and related activities.

4.3.6.1.1 Primary System

The base of the leachate collection and removal system will be defined by the primary geomembrane. On the floor of the lined landfill, the primary geomembrane will be overlain by geotextile cushion, and the granular drainage layer. The granular drainage layer will drain to the primary sump and a perforated pipe will be located along the centerline of the cell to increase flow capacity to the primary sump. Geotextile layers at the top of the leachate collection and removal system will prevent migration of fine soil particles into the gravel or geonet, thus prevent clogging. On the sideslopes, a CDN layer will be used over the geomembrane. The CDN will include bonded geotextiles on both sides of a geonet that increase the interface shear strength. Because of construction difficulties in placing a 30.5-cm thick gravel layer on 3:1 sideslopes, no drainage gravel will be placed on the sideslopes.

The leachate collection and removal system will be covered by the operations layer. The layer will be a minimum 0.9-meter thick, and will provide protection for the underlying liner and drainage materials. The operations layer will cover both the landfill floor and the sideslopes.

The leachate collection and removal system will be designed to accommodate the 25-year, 24-hour storm, as required by WAC regulations. However, the EPA recognizes the need to temporarily store leachate from such rare events (EPA 1985). Should a storm event that exceeds the 25-year, 24-hour storm event occur, the leachate collection and removal system sump was designed to temporarily store leachate at a depth greater than 30.5 centimeters, as opposed to the alternative of constructing an excessively large leachate collection tank.

The leachate collection and removal system sump will be equipped with two sump pumps. One pump will be a high capacity pump capable of rapid removal of large volumes of leachate, will be suitable for the transfer of batch quantities of leachate, and will handle the larger volumes of leachate anticipated from the 25-year, 24-hour storm event. The other pump will be a low-capacity submersible pump located in the base of the sump. The sump pumps will be located in a sump trough. The sump trough was designed to contain the leachate below the intake of these pumps, within the smallest possible area, to minimize the residual leachate volume after each pumping cycle. The pumps will be fabricated from stainless steel or other corrosion resistant material.

4.3.6.1.2 Leak Detection System

The base of the LDS will be formed by the secondary geomembrane. The leak detection system will be similar to the LCRS, except that the perforated collection pipe is not included. The perforated pipe will not be needed because high flow capacity will not be required for the low leachate volumes.

The LDS will drain to the LDS sump, which will be located immediately below the LCRS sump. Because of the low volumes, the LDS will be equipped with only one low-capacity submersible pump to meet WAC 173-303-665(8)(a).

4.3.6.1.3 Response Action Plan

In compliance with regulatory requirements, a response action plan (Appendix 4C) was prepared for the lined landfill. In accordance with EPA guidance, the action leakage rate was calculated as "the maximum design flow rate that the leak detection system can remove without the fluid head on the bottom liner exceeding 30.5 centimeters" (EPA 1992). If the action leakage rate were exceeded, DOE will do the following:

- Notify the appropriate regulatory authority in writing of the exceedence within 7 days of the determination

- Submit a preliminary written assessment to the appropriate regulatory authority within 14 days of the determination, on the amount of liquids, likely sources of liquids, possible location, size, cause of any leaks, and short-term actions taken and planned

- Determine to the extent practicable the location, size, and cause of any leak

- Determine whether waste receipt should cease or be curtailed, whether any waste should be removed from the unit for inspection, repairs, or controls, and whether the unit should be closed

- Determine any other short-term and/or long-term actions to be taken to mitigate or stop any leaks

- Within 30 days after the notification that the action leakage rate has been exceeded, submit to the appropriate regulatory authority the results of the analyses specified in the following paragraphs, the results of actions taken, and actions planned. Monthly thereafter, as long as the flow rate in the leak detection system exceeds the action leakage rate, DOE will submit to the appropriate regulatory authority, a report summarizing the results of any remedial actions taken and actions planned.

The leachate will be analyzed for RCRA constituents as appropriate. A procedure will be in place to address details of analysis (i.e., analyses, constituents, test methods, etc.). If the analytical results on leakage fluids indicate that these constituents are present, and if the constituents can be traced to a particular type of waste placed in a known area of the lined landfill, it might be possible to estimate the location of the leak. In addition, waste packages might not undergo enough deterioration during the active life of the landfill to permit escape of the contents; it is possible that the leachate might be clean or the composition too general to show a specific source location.

If the source location cannot be identified, large-scale removal of the waste and operations layer to find and repair the leaking area of the liner would be one option for remediation. However, this risks damaging the liner. In addition, waste would have to be handled, stored, and replaced in the landfill. Backfill would need to be removed from around any waste packages to accomplish this. If the waste packages were damaged during this process, the risk of accidental release might be high. For these reasons, large-scale removal of waste and liner system materials will not be a desirable option and will not be implemented except as a last resort.

The preferred alternative will depend on factors such as the amount of waste already in the landfill, the rate of waste receipt, the chemistry of the leachate (i.e., is it clean?), the availability of other disposal units, and similar considerations. Therefore, no single approach will be selected at this time. If necessary, an interim solution could be implemented while the evaluation and permanent remediation were performed. Examples of potential approaches include the following.

- The surface of the waste could be graded to direct run-off into a shallow pond. The surface would be covered with the low-hydraulic conductivity layer (geomembrane). Precipitation would be pumped or evaporated from the pond and would not infiltrate the waste already in the lined landfill. Waste would be placed only during periods of dry weather, and stored at other onsite TSD units at other times. This type of approach also could be used to reduce leakage immediately after the action leakage rate was exceeded, while other remediation options were evaluated.

- Partial construction of the final closure cover could begin earlier than planned. This would reduce infiltration into the lined landfill, and possibly reduce the leakage rate if the cover were constructed over the failed area.

- A layer of low-hydraulic conductivity soil could be placed over the existing waste, perhaps in conjunction with a geomembrane, to create a second 'primary' liner higher in the lined landfill. This new liner would intercept precipitation and allow its removal.

- A rigid-frame or air-supported structure could be constructed over the landfill to ensure that no infiltration occurs. Although costly, this approach could be less expensive than constructing a new landfill.

In general, the selected remediation efforts will be progressive. Those remediation methods that are judged to be the least difficult and the most cost effective will be used first. If these efforts are not effective, more difficult or expensive options would be used.

4.3.6.2 Equivalent Capacity [D-6f(2)]

The CDN drainage layers used will be available commercially and will have equivalent flow capacity to a 30.5-centimeters layer of granular drainage material with a hydraulic conductivity of 1×10^{-2} centimeter per second.

4.3.6.3 Grading and Drainage [D-6f(3)]

In accordance with EPA guidance, all areas of the lined landfill floor (except the sump bottoms) will be graded at a slope of at least 2 percent towards the centerline of each cell. The centerline of each cell will have a 1 percent slope lengthwise towards the sump, to facilitate drainage and avoid ponding on the liners. Grading tolerances have been established to ensure proper slope is maintained.

4.3.6.4 Maximum Leachate Head [D-6f(4)]

The maximum head on the primary liner will be less than 30.5 centimeters, except for rare storm events as discussed in Section 4.3.6.1 and the LCRS sump trough. The sump was sized and designed to provide adequate surge storage to prevent leachate build up on the primary liner.

4.3.6.5 System Compatibility [D-6f(5)]

The primary and secondary leachate collection and removal systems will be composed of inert geologic materials (sand and gravel), high-density polyethylene, and other geosynthetic materials such as polypropylene. As described in Section 4.3.5.2, the geosynthetics were evaluated for compatibility with the expected leachate. To ensure that the geosynthetics used in the lined landfill are similar chemically to those evaluated, manufacturers will be required to submit quality control certificates and other manufacturing information on all materials.

Before a new waste constituent, not previously analyzed (based on a dangerous waste number), is allowed in the lined landfill, the waste constituent will be evaluated for compatibility with the liner (e.g., identified in 9090A test results or other appropriate testing methods, etc.). Other materials could contact the leachate, for example:

- HDPE and Polyvinyl chloride (PVC) piping will be used
- Polyvinyl chloride and other plastics in miscellaneous uses
- Leachate tank will use a chemically resistant flexible geomembrane liner system.

Compatibility of these materials with the expected leachate was considered in the landfill liner system design. Compatibility of these materials will be of lesser concern, because items that consist of these materials will be located entirely within the containment area. Failure of these items would not result in a dangerous waste release, and the materials would be replaced or repaired.

4.3.6.6 System Strength [D-6f(6)]

Stability of drainage layer, strength of piping, and prevention of clogging are discussed in the following sections.

4.3.6.6.1 Stability of Drainage Layers [D-6f(6)(a)]

As described in Sections 4.3.3.3 and 4.3.5.3, the stability of the liners and leachate collection and removal systems on the sideslopes was evaluated as part of detailed design (Appendix 4A). To provide sufficiently high shear strengths at the interfaces between geosynthetic components, textured geomembranes and thermally bonded CDNs are used.

Bearing capacity of the drainage and sump gravels is expected to be adequate, based on typical strength values for granular materials.

The transmissivity of the drainage layers under the combined load of the waste and cover was addressed in the design and will be adequate to support leachate removal.

4.3.6.6.2 Strength of Piping [D-6f(6)(b)]

The drain pipes in the primary drainage and sump gravel and sideslope riser pipes will be high-density polyethylene pipe. During detailed design, the required wall thickness of the pipe was determined according to the manufacturer's recommendations and standard analytical methods used by the piping industry (Appendix 4A). In these analyses, the ultimate load (derived from the estimated weight of the waste and cover) was used, the allowable deflections were limited to 5 percent, and conservative values for soil modulus and lateral confinement were assumed.

4.3.6.7 Prevention of Clogging [D-6f(7)]

The geotextiles that separate the drainage layers from adjacent soil layers was selected based on the ability of the geotextiles to retain the soil and to prevent the soil from entering the leachate collection and removal systems. In addition, the amount of fine material in the drainage and sump gravels will be limited by specification to less than a few percent, and will not be expected to cause clogging problems (Appendix 4A). Because the waste disposed in the lined landfill will be required to satisfy LDR (RCW 70.105.050(2), WAC 173-303-140, and 40 CFR 268), the amount of organic material will be minimal, and consequently biologic clogging will not be a problem.

4.3.7 Liner System, Construction and Maintenance [D-6g]

Details relating to the liner system construction and maintenance are discussed in the following sections.

4.3.7.1 Material Specifications [D-6g(l)]

Material specifications are provided in the following sections for each of the materials used in the liner system.

4.3.7.1.1 Synthetic Liners [D-6g(1)(a)]

As described in Section 4.3.3.1, both the primary and secondary geomembrane liners will consist of high-density polyethylene. As described in Section 4.3.3.1.4, the primary barrier also contains a geosynthetic clay liner placed on the floor area only. Detailed specifications were prepared for the lined landfill as part of the design process.

4.3.7.1.2 Soil Liners [D-6g(1)(b)]

As described in Section 4.3.3.1, the soil liner will consist of imported bentonite (expansive clay) blended with fine soil deposits on or next to the IDF. The fine soil will be free of roots, woody vegetation, rocks greater than 2.54 centimeter in diameter, and other deleterious material. The bentonite content will depend on the characteristics of the fine soil. Mixing will be performed under carefully controlled conditions in a pugmill or other approved alternatives. The admix will be placed and compacted to achieve an in-place hydraulic conductivity of 1×10^{-7} centimeter per second or less. The final surface of the soil liner will be rolled smooth before placing the overlying geomembrane. Additional specifications were prepared for the lined landfill as part of the design process.

4.3.7.1.3 Leachate Collection and Removal System [D-6g(1)(c)]

Drainage and sump gravel will consist of hard, durable, rounded to subrounded material. The gravel will be washed and the amount of fine material (i.e., passing the number 200 sieve) will be limited to a few percent. The hydraulic conductivity of the gravel will be 1×10^{-2} centimeter per second or greater. Additional specifications were prepared as part of the design process.

For geotextiles and geonets, the composition, thickness, transmissivity, unit weight, apparent opening size, strength, and other properties were determined during detailed design based on results of engineering analyses, experience, and industry standard approaches.

4.3.7.2 Construction Specifications [D-6g(2)]

Construction requirements for major components of the lined landfill are summarized in the following sections.

4.3.7.2.1 Liner System Foundation [D-6g(2)(a)]

The excavated subgrade surfaces will be moisture conditioned and compacted as required to achieve the specified compaction before placing the admix layer.

4.3.7.2.2 Soil Liners [D-6g(2)(b)]

The soil and bentonite will be blended thoroughly and moisture conditioned so that the admix will be uniform and homogeneous throughout. The admix layer will be placed in loose lifts and compacted so that the compacted lift meets the requirements of the Construction Quality Assurance Plan. Each new lift of admix will be kneaded into the previously placed lift. The methods for admix preparation, type of compaction equipment, number of passes, and other details of the placement process will be determined by constructing a test fill section before placing admix in the lined landfill.

4.3.7.2.3 Synthetic Liners [D-6g(2)(c)]

To protect the overlying geomembranes, the admix surface will be smooth and free of deleterious material. In all cases, the high-density polyethylene liner will be deployed with the length of the roll parallel to the slope. Adjacent panels will be overlapped and thermally seamed using fusion or extrusion methods. Seams will be inspected continuously using air pressure tests. A vacuum box will be used in areas where air pressure tests cannot be used (e.g., extrusion weld areas). Destructive seam tests (ASTM D4437) (peel and adhesion) will be performed on samples taken at regular intervals. Placing the overlying geosynthetic layers when practicable will protect the geomembranes.

4.3.7.2.4 Leachate Collection and Removal Systems [D-6g(2)(d)]

Drainage and sump gravel will be placed and spread carefully over the underlying geosynthetics using suitable equipment to prevent damage. Hauling and placing equipment will operate on a minimum thickness of soil above any geosynthetic layer to avoid damage. Geosynthetic layers in the leachate collection and removal system will be deployed, overlapped, and joined (e.g., tying for geonets, sewing for geotextiles) according to standard industry practice and the manufacturers' recommendations. Drainage and riser pipes will be installed in the landfill. Pipes will be bedded carefully and the landfill will be backfilled to provide adequate lateral support. Pumps and other mechanical components will be installed according to manufacturers' recommendations.

4.3.7.3 Construction Quality Control Program [D-6g(3)]

A construction quality assurance plan (Appendix 4B) will be used during lined landfill construction and establishes in detail the following in accordance with WAC 173-303-335:

Program must include observations, test, and measurements to ensure

- proper construction of all components of the liners, leachate collection and removal system,

- conformity of all materials used in the design.

4.3.7.4 Maintenance Procedures for Leachate Collection and Removal Systems [D-6g(4)]

The accessible components of the leachate collection and removal system will be maintained according to preventive maintenance methods. These methods will require periodic testing to prove that the equipment, controls, and instrumentation are functional and are calibrated properly. Testing intervals will be derived from applicable regulations and manufacturer's recommendations. All pumps and motors will be started or bumped monthly or at intervals suggested by the manufacturer; first, to demonstrate that the pumps and motors are functional, and second, to move the bearing(s) so that the bearing surfaces do not seize or become distorted. Instruments will be calibrated annually or at intervals suggested by the manufacturer. When applicable, the preventive maintenance methods will include calibration instructions. The following instruments will require annual calibration:

- LCRS sump level indicator
- LDS sump level indicator

Other instrumentation inside the leachate handling and storage facilities will also require routine maintenance.

4.3.7.5 Liner Repairs During Operations [D-6g(5)]

Because of the 0.9-meter-thick operations layer, damage to the liner system is not expected. If damage did occur, the operations layer could be removed laterally as far as required. Underlying geosynthetic and gravel layers will be removed until an undamaged layer is encountered. The damaged layers will be repaired and replaced from the lowest layer upwards using similar methods to those employed during construction. Most repairs to the geomembranes will be performed using a patch, which will be placed, welded, and tested by construction quality assurance personnel.

4.3.8 Run-On and Run-Off Control Systems [D-6h]

Because of the sandy soils, small drainage area, and arid climate at the IDF, stormwater run-on and run-off will not be expected to require major engineered structures. Interceptor and drainage ditches will be adequate for run-on and run-off control. The 25-year, 24-hour precipitation event was the design storm used to size the lined landfill systems. Beyond this, surface water evaluation is highly site-specific, and appropriate analyses were performed as part of detailed design for the lined landfill.

4.3.8.1 Run-On Control System [D-6h(l)]

Run-on will be controlled by drainage ditches or berms around the perimeter of the lined landfill. Any overland flow approaching the landfill will be intercepted by the ditches or berms and will be conveyed to existing drainage systems or suitable discharge points. All the drainage ditches or berms were designed to handle the peak 25-year flow from the potential drainage area. By using low channel slopes, design flow velocities in the ditches will be maintained below established limits for sand channels.

Between the landfill crest and the perimeter road, the area will be graded to provide drainage toward the perimeter road. The perimeter road will be sloped outward, at a grade of approximately 2 percent, to provide drainage away from the landfill. On the outside of the perimeter road drainage ditches will be excavated to provide drainage away from the landfill.

4.3.8.1.1 Design and Performance [D-6h(1)(a)]

Design and performance details were determined for the landfill as part of the detailed design process.

4.3.8.1.2 Calculation of Peak Flow [D-6h(1)(b)]

Computation of design discharge for the drainage ditches or berms was performed using standard analytical methods, such as the Rational Method or the computer program HEC-1 (USACE 1981). The 25-year, 24-hour precipitation depth is 4.0 centimeters, based on precipitation data recorded from 1947 to 1969 (PNL-4622). The tributary area for each section of ditch or berm was based on local topography.

4.3.8.2 Run-Off Control System [D-6h(2)(a and b) and (3)]

There will be no run-off from the lined landfill because the landfill will be constructed below grade. Any precipitation falling on the landfill will be removed by either evapotranspiration or the leachate collection and removal systems. Therefore, a run-off control system will not be needed.

4.3.8.3 Construction [D-6h(4)]

The drainage ditches or berms around the lined landfill will be constructed with conventional earthmoving equipment such as graders and small dozers.

4.3.8.4 Maintenance [D-6h(5)]

The drainage ditches or berms will require periodic maintenance to ensure proper performance. The most frequent maintenance activity, beyond periodic inspection, will be cleaning the ditches or berms to remove obstructions caused by windblown soil and vegetation (e.g., tumbleweeds). After rare storm events, regrading of the ditch bottom or repair of the berm might be required to repair erosion damage. This is expected to occur infrequently; however, inspections will be conducted after 25-year storm events or at least annually.

4.3.9 Control of Wind Dispersal [D-6i]

The IDF will use varied methods to prevent wind dispersal of mixed waste and backfill materials, depending on the waste form. Methods to prevent wind dispersal include containerizing, stabilizing, grouting, spray fixitants, and backfill. Leachate may also be used to aid in compaction and dust control. Sometimes the natural-form of the waste precludes the need for wind dispersal protection, (i.e., scrap piping and other solid debris). In other instances, the operating contractor implements a wind speed restriction during handling, and immediately backfills the waste to prevent wind dispersal.

4.3.10 Liquids in Landfills [D-6j]

Free liquids will not be accepted except as allowed by Appendix 3A, section 1.2. Waste received at the IDF must comply with waste acceptance requirements.

4.3.11 Containerized Waste [D-6k]

Containerized waste received in the IDF lined landfill will be limited to a maximum of 10 percent void space. Several inert materials (diatomaceous earth, sand, lava rock) will be used as acceptable void space fillers for waste that does not fill the container.

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Replacement drawings for Appendix 4A, located in Volume 4 of 4

Replacement Construction Specification sections for Appendix 4A, located in Volume 4 of 4

SECTION 02200--SITE PREPARATION

PART 1--GENERAL

WORK INCLUDED:

This section describes requirements for clearing, grubbing and stripping of the IDF project area and associated facilities.

DEFINITIONS:

Interfering or Objectionable Material: Trash, rubbish, and junk.

Clearing: Removal of existing vegetation and interfering or objectionable material lying on or protruding above ground surface.

Grubbing: Removal of vegetation and other organic matter including sagebrush, stumps, buried logs, and roots greater than 2 inches caliper to a depth of 6 inches below subgrade.

Stripping: Removal of topsoil and other organic matter. Strippings suitable for topsoil shall be limited to upper 6 inches.

Project Limits: Areas actually needed for site improvements, stockpiles, and borrow areas, as shown or specified, within which Work is to be performed.

RAW WATER SUPPLY:

Depending on the availability of connections to the raw water pipeline system, water for dust control may be obtained either from an existing water fill station on 4th Street near the west exit of the 200 East Area or from the raw water line that crosses the IDF site. A new raw water pipeline is being installed as part of Schedule A of the IDF project.

Whether water is obtained from the existing water fill station or from new facilities on the IDF site, use of connections to the raw water system shall be in accordance with guidance from the Hanford Site Water Purveyor. Use and discharge of raw water during construction for construction activities, including dust control and fire protection, shall be controlled through the Hanford Site Water Purveyor, and shall comply with WAC 173-200 and the State Waste Discharge Permit No. ST 4508. For any use of existing water fill station or a water connection on the IDF site, ~~the rate of water withdrawal shall be limited to approximately 200 gpm through the use of an orifice plate. The plate shall be sized for a source water pressure of 115 psi.~~ the total of all IDF project water usage from the raw water system shall not exceed 1,500 gpm. There is no guarantee that the 1,500 gpm will be available at all times or that will be available from a single location on the IDF water system. In addition, the maximum water use limitation may be periodically reduced by the Hanford Site Water Purveyor depending on the other Hanford site demands on the raw water system and/or the availability of raw water pumping capacity within the Hanford raw water system.

When using any connection to the raw water system, the Construction General Contractor shall take whatever means are necessary to operate fill stations and other connections in such a manner to prevent causing water hammer. If water usage from the system is found to cause water hammer, the Hanford Site Water Purveyor may require the use of orifice plates, changes to valve operation methods, and/or a reduction in water use at a water connection as necessary to eliminate the water hammer. For any onsite fill station, Construction General Contractor shall provide a water storage tank (minimum size 20,000 gallons) equipped with a float actuated fill valve to minimize demand surges on the Hanford Water Supply.

SUBMITTALS–APPROVAL REQUIRED:

See Section 01300, SUBMITTALS, for submittal procedures.

Site Preparation Plan: Prior to any mobilization of equipment to the site, the Construction General Contractor shall submit a Site Preparation Plan for approval. This plan shall include the following information as a minimum:

> Detailed description of the proposed method for clearing, grubbing, and stripping the site. The plan shall identify those areas of the project site which will be cleared, grubbed and stripped. In addition, it will identify staging areas, stock pile areas, and the sequence in which the site preparation will be executed.

Dust Control Plan: Prior to any earthwork activities on the project site such as site preparation and excavation, Construction General Contractor shall submit a Dust Control Plan for approval. The plan shall identify methods and equipment to minimize/control dust generation during all earthwork operations and include the following minimum requirements:

> Continuous control of dust generation during excavation and backfill placement, etc.

> Continuous control of wind-generated dust, including disturbed areas that are not being actively worked.

> Keep haul roads watered to control dust.

> A minimum two full water trucks (5,000 gallons each) for the duration of the project.

> Apply water or other approved dust suppressants as minimum to keep visible dust to a minimum during execution of Work.

> Appropriate hand-held hose lines, sprinklers, and other equipment as needed to access and control non-vehicle access areas such as borrow and stockpile side slopes.

> Maintain and protect native cover where possible, through minimization of site disturbance.

Limit access road development to minimum necessary to execute work.

Stabilization of inactive disturbed work areas by longer term methods such as matting, tack and mulch or crusting agents.

Implementation of permanent stabilization on a regular basis when sufficient area exists for application or as needed to control dust.

General Construction Contractor shall use daily field reports to document dust control measures implemented and their effectiveness.

These dust control plan items are required to satisfy the requirements of Section 3.0 - Mitigation of Potential Dust Impacts from Construction Activities of the "Mitigation Action Plan for USDOE, Hanford Site, Immobilized Low-Activity Waste (ILAW) Disposal Site Construction (Project W-520)," prepared by PNNL for USDOE.

Submit details of raw water supply, storage, and water withdrawal limiting equipment as part of the Dust Control Plan.

SCHEDULING AND SEQUENCING:

The sequence of the activities listed below shall be followed by the Construction General Contractor for the site preparation work.

Initial site preparation activities shall commence only after Dust Control Plan and Site Preparation Plan have been approved.

Following the approved Site Preparation Plan, establish an adequate water supply source for dust control use.

After establishing an adequate water supply and sediment controls, proceed with site preparation activities as specified.

PART 2--PRODUCTS (NOT USED)

PART 3--EXECUTION

GENERAL:

Clear, grub, and strip only areas actually needed for stockpiles, borrow, or site improvements within limits shown and specified.

Do not injure or deface vegetation that does not require removal.

As an initial step in clearing the site, the General Construction Contractor shall remove all trash, rubbish, and junk from the site. This material shall be disposed in accordance with Division 1 requirements.

CLEARING:

Cut off shrubs, brush, weeds, and grasses to within 4 inches of ground surface.

GRUBBING:

Grub all areas where excavations, fill, roadways, structures, and ditches are to be placed.

Vegetation other than noxious weeds, removed by the clearing and grubbing, shall be placed in stockpile with the strippings to be used as topsoil. Place vegetation at the base of the strippings stockpile area and track with equipment to break apart and crush the material. Obtain Construction Manager approval of the vegetation placement.

STRIPPING:

Strip all areas where excavations, borrow areas, stockpiles, fills, roadways, structures, and ditches are to be placed, to remove organic materials. Do not remove subsoil with topsoil.

Stockpile strippings from the upper 6 inches below ground surface after clearing and grubbing, meeting requirements for topsoil in Section 02920, RECLAMATION AND REVEGETATION, separately from other excavated material at either the designated stockpile area location shown on the Drawings, or other areas as approved by the Construction Manager.

IDF RAW WATER CONNECTIONS:

General Construction Contractor shall take necessary steps to prevent freezing and/or damage to the IDF raw water system connections.

DISPOSAL:

Clearing and Grubbing Debris: Bury vegetation that is not suitable for topsoil at a designated area as directed by the Construction Manager. Disposal of the remaining interfering or objectionable material shall be in accordance with Division 1 requirements.

Strippings: Dispose of strippings that are unsuitable for topsoil as specified above for clearing and grubbing debris.

Burning Prohibited: No burning of any materials generated during the site preparation work will be allowed at the site.

END OF SECTION 02200

SECTION 02315--FILL AND BACKFILL

PART 1--GENERAL

WORK INCLUDED:

This section describes placement and testing of fill and backfill in general areas of the site (including stockpiles).

REFERENCES:

The following is a list of standards which may be referenced in this section:

ASTM INTERNATIONAL (ASTM)

ASTM D75	Standard Practice for Sampling Aggregates
ASTM D422	Standard Test Method for Particle-Size Analysis of Soils
ASTM D698	Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3))
ASTM D1140	Standard Test Method for Amount of Material in Soils Finer Than the No. 200 (75 micrometer) Sieve
ASTM D1556	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D2216	Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
ASTM D2922	Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D3017	Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)

DEFINITIONS:

Relative Compaction:

Ratio, in percent, of as-compacted field dry density to laboratory maximum dry density as determined in accordance with ASTM D698.

Apply corrections for oversize material to maximum dry density.

Optimum Moisture Content: Determined in accordance with ASTM D698 specified to determine maximum dry density for relative compaction.

Prepared Ground Surface: Ground surface after completion of required demolition, clearing and grubbing, scalping of sod, stripping of topsoil, excavation to grade, and subgrade preparation.

Completed Course: A course or layer that is ready for next layer or next phase of Work.

Lift: Loose (uncompacted) layer of material.

Geosynthetics: Geotextiles, geocomposites, geosynthetic clay liner, or geomembranes.

Well-Graded:

A mixture of particle sizes with no specific concentration or lack thereof of one or more sizes.

Does not define numerical value that must be placed on coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.

Used to define material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids.

Influence Area: Area within planes sloped downward and outward at 60-degree angle from horizontal measured from:

1-foot outside outermost edge at base of foundations or slabs.
1-foot outside outermost edge at surface of roadways or shoulder.
0.5-foot outside exterior at spring line of pipes or culverts.

Imported Material: Materials obtained from sources offsite, suitable for specified use.

Standard Specifications: When referenced in this section, shall mean Standard Specifications for Road, Bridge and Municipal Construction, as published by the Washington State Department of Transportation, 2002 edition, English units.

SLDS: Secondary Leak Detection System.

Permanent Stockpile: Stockpile of material that remains at the completion of construction.

SUBMITTALS–APPROVAL REQUIRED:

See Section 01300, SUBMITTALS, for submittal procedures.

Submit gradation test results for all imported materials from independent testing laboratory as specified in paragraph SOURCE QUALITY CONTROL in Part 2.

Stockpile Plan: Prior to any excavation activities associated with construction of the IDF, Construction General Contractor shall submit a Stockpile Plan for approval. The plan shall include the following information:

Scale drawing, using the project plans as a base, which shows the proposed location for stockpiles on the project site. Show all access roads around stockpiles. Address stockpile locations during construction of the IDF and permanent stockpiles which will remain upon completion of construction activities for this project.

Stockpile layout drawings which show the estimated location of toe of slope and top of slope for each stockpile. Drawings shall show plan and typical sections and shall be fully dimensioned.

Plan shall show how differing materials encountered during the excavation will be segregated for future use. This includes material for use as topsoil, admix base soil, and operations layer. Also show a stockpile area for material to be used in the future as clean backfill during landfill operations by the Tank Farm Contractor.

Method by which stockpile compaction will be achieved.

Dust control for the stockpiles during active use and until grass is established.

Placing of topsoil, seeding, fertilizing, and mulching each stockpile after active use of stockpile is finished in accordance with Section 02920, RECLAMATION AND REVEGETATION.

SUBMITTALS–APPROVAL NOT REQUIRED:

Information/Record (IR):

Qualifications of independent testing laboratory.

Qualifications of construction quality control personnel.

SEQUENCING AND SCHEDULING:

Complete applicable Work specified in Sections 02316, EXCAVATION, and 02319, SUBGRADE PREPARATION, prior to placing fill or backfill.

PERMIT REQUIREMENTS:

A backfill and fill permit is required for each backfill and fill work element. Construction General Contractor shall obtain from Tank Farm Contractor and post before starting backfill and fill work, as specified in Division 1, General Requirements.

CONSTRUCTION QUALITY ASSURANCE:

The Construction General Contractor shall accommodate all CQA activities described herein and in the CPA Plan for this project. The CQA Plan is made part of these Specifications by reference.

The CQA Certifying Engineer shall determine in-place density and moisture content by any one or combination of the following methods: ASTM D2922, ASTM D3017, ASTM D1556, ASTM D2216, or other methods approved by the Construction Manager.

Testing requirements and locations will be determined by the CQA Certifying Engineer. Construction General Contractor shall cooperate with the CQA Certifying Engineer and testing work by leveling small test areas designated by the CQA Certifying Engineer. Backfill test areas at Construction General Contractor's sole expense. The CQA Certifying Engineer may have any material tested at any time, location, or elevation.

After Construction General Contractor makes repairs to any areas failing a test, the Construction General Contractor shall rerun appropriate tests, subject to the approval of the CQA Certifying Engineer, to demonstrate the area meets specifications, at the Construction General Contractor's sole expense.

The following minimum test schedule shall be assumed. Additional tests may be required as directed by CQA Certifying Engineer.

In-place density tests shall be made on the following minimum schedule:

Earthfill: One per 5,000 square feet (ft^2) per lift.

Structural Fill: One per 2,500 ft^2 per lift.

Subgrade Preparation: Four per acre.

Operations Layer (Outside Edge of Liner): One per 5,000 ft^2 per lift.

Operations Layer Material (SLDS): Two (2) per lift.

Standard Proctor (ASTM D698) laboratory density curves (five-point minimum) shall be performed for each material by the CQA Certifying Engineer. Samples of native materials used for embankment and backfill and samples of imported materials shall be taken at locations as specified by CQA Certifying Engineer.

Gradation tests (sieve analysis) shall be performed in accordance with ASTM D422 on operations layer material obtained from required excavations to demonstrate the materials meet the Specifications. Samples of operations layer material shall be taken from each 10,000 cubic yards of placed material in accordance with ASTM D75.

PART 2--PRODUCTS

EARTHFILL:

Excavated material from required excavations and designated borrow sites, free from rocks larger than 4 inches in the greatest dimension, from roots and other organic matter, ashes, cinders, trash, debris, and other deleterious materials.

STRUCTURAL FILL:

Conform to the requirements of Section 9-03.9(3) Crushed Surfacing-Base Course in the Standard Specifications, except for structural fill beneath leachate storage tank. At this location, utilize crushed surfacing-top course conforming to the requirements of Section 9-03.9(3).

Material selected from excavation meeting the requirements of Section 9-03.9(3) Crushed Surface-Base Course may be used for structural fill.

OPERATIONS LAYER:

Meeting the requirements of earthfill above and having a maximum of 25 percent by weight passing the No. 200 U.S. sieve and a maximum particle size of 2 inches.

DRAIN GRAVEL:

Material for drain gravel shall conform to the requirements of Section 9-03.12(4) of the Standard Specifications except material shall be subrounded to rounded gravel. Crushed rock and angular gravel shall not be allowed.

CRUSHED SURFACING:

Material for crushed surfacing-base course and top course shall conform to the requirements in Section 9-03.9(3) of the Standard Specifications.

QUARRY SPALLS:

Quarry spalls shall consist of broken stone free from segregation, seams, cracks, and other defects tending to destroy its resistance to weather and shall meet the following requirements for grading:

Maximum Size: 8 inches.

50 percent by weight shall be larger than 3 inches.

Minimum Size: 3/4 inch.

SOURCE QUALITY CONTROL:

Gradation tests performed in accordance with ASTM D422 by a qualified independent testing laboratory shall be made for imported materials on samples taken at place of production prior to shipment. Imported materials shall not be shipped without submittal approval. Samples of the finished product for gradation testing shall be taken from each 2,000 tons of prepared materials in accordance with ASTM D75. Test results shall be submitted to Construction Manager within 48 hours after sampling.

BASE SOIL:

As specified in Section 02666, ADMIX LINER.

WATER FOR MOISTURE CONDITIONING:

See Section 02200, SITE PREPARATION, for raw water supply availability and requirements for proper compaction.

PART 3--EXECUTION

GENERAL:

Keep placement surfaces free of water, debris, and foreign material during placement and compaction of fill and backfill materials.

Place and spread fill and backfill materials in horizontal lifts of uniform thickness as specified in paragraphs BACKFILL UNDER AND AROUND STRUCTURES and FILL, in a manner that avoids segregation, and compact each lift to specified densities prior to placing succeeding lifts. Slope lifts only where necessary to conform to final grades or as necessary to keep placement surfaces drained of water.

Do not place fill or backfill, if fill or backfill material is frozen, or if surface upon which fill or backfill is to be placed is frozen.

Tolerances:

Final Lines and Grades: Within a tolerance of 0.1-foot unless dimensions or grades are shown or specified otherwise.

Grade to establish and maintain slopes and drainage as shown. Reverse slopes are not permitted.

Settlement: Correct and repair any subsequent damage to structures, pavements, curbs, slabs, piping, and other facilities, caused by settlement of fill or backfill material.

BACKFILL UNDER AND AROUND STRUCTURES:

Under Facilities: Backfill with earthfill or structural fill, as shown on the Drawings, for each structure or facility. Place earthfill or structural fill in lifts of 6-inch maximum compacted thickness and compact each lift to minimum of 95 percent relative compaction as determined in accordance with ASTM D698.

FILL:

Outside Influence Areas Beneath Structures, Slabs, Piping, and Other Facilities: Unless otherwise shown, place earthfill as follows:

Allow for 6-inch thickness of topsoil where required.

Maximum 8-inch thick lifts.

Place and compact fill across full width of embankment.

Compact to minimum 95 percent relative compaction.

REPLACING OVEREXCAVATED MATERIAL:

Replace excavation carried below grade lines shown as follows:

Beneath IDF Cell: Earthfill as specified herein.

Beneath Fill or Backfill: Same material as specified for overlying fill or backfill.

Beneath Structures and Roadways: Structural fill or earthfill as shown on the Drawings and specified herein.

TOPSOIL:

Place topsoil on areas disturbed by construction and on permanent stockpile slopes in accordance with Section 02920, RECLAMATION AND REVEGETATION.

STOCKPILING:

Material shall be placed in permanent stockpiles as follows:

Place material in maximum 2-foot lifts and compact with a minimum four passes with earth-moving equipment.

Maximum slopes shall be 3H:1V. Minimum slopes shall be 3 percent to promote drainage.

Upper 2 feet of stockpile surface shall be placed in maximum 12-inch thick lifts and compacted to minimum 90 percent relative compaction as determined in accordance with ASTM D698.

Place 6-inch thick layer of topsoil on completed slopes in accordance with Section 02920, RECLAMATION AND REVEGETATION.

Permanent stockpiles shall be seeded, fertilized, and mulched when each stockpile is completed and as directed by the Engineer in accordance with Section 02920, RECLAMATION AND REVEGETATION.

PLACING CRUSHED SURFACING:

Place crushed surfacing base course and top course at locations shown on the Drawings. Placement shall conform to Section 4-04.3 of the Standard Specifications.

PLACING DRAIN GRAVEL AND OPERATIONS LAYER OVER GEOSYNTHETICS:

Place material over geosynthetics as specified in Sections 02371, GEOTEXTILES; 02661, GEOMEMBRANES; and 02667, GEOSYNTHETIC CLAY LINER (GCL).

Compaction requirements for drain gravel around pipes and the sumps are specified in Section 02320, TRENCH BACKFILL.

Operations layer within lining system limits, except as specified for SLDS sump area, shall be placed in 12-inch thick lifts and track-walked into place with a minimum two passes with a Caterpillar D6M-LGP or equal. Operations layer material within SLDS sump area shall be placed in 12-inch thick lifts and compacted to 90 percent relative compaction. Operations layer placed outside edge of liner, such as for shine berm, shall be placed in maximum 8-inch thick lifts and compacted to 95 percent relative compaction.

Place material to the lines and grades shown and compact by tracking a minimum two passes with spreading equipment.

QUARRY SPALLS PLACEMENT:

Quarry spalls shall be placed around the ends of stormwater pipes to provide erosion protection in accordance with the Plans and as directed by the Engineer. Quarry spalls shall be placed in such a manner that all relatively large stones are essentially in contact with each other and voids are filled with the finer materials to provide a well graded compact mass. Finished surface shall be free from irregularities. The stone shall be dumped on the ground in a manner that will ensure the stone attains its specified thickness in one operation. When dumping or placing, care shall be used to avoid damaging the underlying material. Stone shall not be dumped from height greater than 12 inches above surface. Material placement shall be started from the bottom of the installation, working toward edges. Geotextile damaged during the placement of quarry spalls shall be repaired at Construction General Contractor's sole expense.

CONSTRUCTION QUALITY CONTROL:

The Construction General Contractor shall perform in-place density and moisture content tests with own qualified personnel or with a qualified independent testing laboratory as specified in paragraph CONSTRUCTION QUALITY ASSURANCE, to be observed by the Construction Manager, on the following minimum schedule:

Material Placed by Stockpile (Upper 2 Feet): One per 10,000 ft^2 per lift.

Construction General Contractor shall submit qualifications of personnel or independent testing laboratory that will perform construction quality control.

END OF SECTION 02315

SECTION 02319--SUBGRADE PREPARATION

PART 1--GENERAL

WORK INCLUDED:

This section describes requirements for preparation of subgrades in areas to receive fill.

REFERENCES:

The following is a list of standards which may be referenced in this section:

ASTM INTERNATIONAL (ASTM)

ASTM D698-	Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3))

DEFINITIONS:

Optimum Moisture Content: As defined in Section 02315, FILL AND BACKFILL.

Prepared Ground Surface: Ground surface after completion of clearing and grubbing, scalping of sod, stripping of topsoil, excavation to grade, and scarification and compaction of subgrade.

Relative Compaction: As defined in Section 02315, FILL AND BACKFILL.

SLDS: Secondary Leak Detection System.

Subgrade: Layer of existing soil after completion of excavation to grade prior to placement of fill, roadway structure or base for floor slab.

Proof-Rolling: Testing of subgrade as specified herein to identify soft or loose zones requiring correction.

SEQUENCING AND SCHEDULING:

Complete applicable Work specified in Section 02316, EXCAVATION, prior to subgrade preparation.

CONSTRUCTION QUALITY ASSURANCE:

The CQA Certifying Engineer shall determine in-place density and moisture for subgrade preparation as specified in Section 02315, FILL AND BACKFILL.

CQA requirements for geomembrane subgrade preparation are specified in Section 02661, GEOMEMBRANES.

PART 2--PRODUCTS (NOT USED)

PART 3--EXECUTION

GENERAL:

Keep subgrade free of water, debris, and foreign matter during compaction or proof-rolling.

Bring subgrade to proper grade and cross-section as shown on the Drawings, and uniformly compact surface.

Maintain prepared ground surface in finished condition until next course is placed.

PREPARED SUBGRADE FOR ROADWAY, EMBANKMENT, AND STRUCTURES:

After completion of excavation and prior to foundation, road fill, structural fill or embankment construction, compact prepared subgrade to 95 percent relative compaction. Scarify and moisture condition subgrade soil as required to achieve specified compaction. If soft or loose zones are found, correct as specified herein. Proof-roll subgrade with a fully loaded dump truck or equal to detect soft or loose subgrade or unsuitable material.

PREPARED SUBGRADE FOR ADMIX LINER:

Prior to admix liner placement, subgrade shall be backbladed to remove loose soil. Low spots or erosion rills shall be backfilled with structural fill as specified herein. Compact prepared subgrade to 95 percent relative compaction. Scarify and moisture condition subgrade soil as required to achieve specified compaction. If soft or loose zones are found, correct as specified herein. Proof-roll subgrade with a vibratory drum roller or equal to detect soft or loose subgrade or unsuitable material. After compaction and proof-rolling, scarify subgrade surface of 3H:1V side slopes to a minimum depth of 1/2 inch prior to admix liner placement.

PREPARED SUBGRADE FOR ~~SECONDARY~~ GEOMEMBRANE (SECONDARY AND SLDS) AND SECONDARY GCL:

~~After completion of admix liner placement, prepare the subgrade surface for geomembrane placement.~~ At completion of SLDS excavation and grading (SLDS geomembrane) or admix liner placement (secondary geomembrane and GCL), prepare the subgrade surface for geomembrane or GCL placement. The surface shall not have holes, depressions more than 1 inch in a 12-inch width, nor protrusions extending above the surface more than 1/2 inch. Roll surface with smooth-drum roller to form a firm stable base. Allow for leachate piping and sumps or features as shown on the Drawings.

CORRECTION:

Soft or Loose Subgrade:

Adjust moisture content and compact to meet density requirements, or

Over excavate and replace with suitable material from the excavation, as specified in Section 02315, FILL AND BACKFILL.

Unsuitable Material: Over excavate and replace with suitable material from the excavation, as specified in Section 02315, FILL AND BACKFILL. Dispose of unsuitable material excavation in accordance with Article DISPOSAL OF SPOIL in Section 02316, EXCAVATION.

END OF SECTION 02319

SECTION 02320--TRENCH BACKFILL

PART 1--GENERAL

WORK INCLUDED:

This section describes requirements for backfilling of trenches for pipe, conduit, and geosynthetics.

REFERENCES:

The following is a list of standards which may be referenced in this section:

ASTM INTERNATIONAL (ASTM)

ASTM C136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D698	Test Method for Laboratory Compaction Characteristics of Soil using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3))
ASTM D1140	Standard Test Method for Amount of Material in Soils Finer than the No. 200 (75 micrometer) Sieve
ASTM D4318	Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

DEFINITIONS:

Pipe Bedding: Granular material upon which pipes, conduits, cables, or duct banks are placed.

Imported Material: Material obtained by the Construction General Contractor from source(s) offsite.

Lift: Loose (uncompacted) layer of material.

Pipe Zone: Backfill zone that includes full trench width and extends from prepared trench bottom to an upper limit above top outside surface of pipe, conduit, cable or duct bank.

Prepared Trench Bottom: Graded trench bottom after stabilization and installation of bedding material.

Relative Compaction: The ratio, in percent, of the as-compacted field dry density to the laboratory maximum dry density as determined by ASTM D698. Corrections for oversize material may be applied to either the as-compacted field dry density or the maximum dry density.

SUBMITTALS–APPROVAL REQUIRED:

See Section 01300, SUBMITTALS, for submittal procedures.

Submit gradation test results for all imported materials as specified in paragraph SOURCE QUALITY CONTROL in Part 2.

SUBMITTALS–APPROVAL NOT REQUIRED:

Vendor Information (VI): Locator ribbon product data.

PART 2--PRODUCTS

LOCATOR RIBBON:

Ribbon shall be 3 inches wide and shall be red for all electrical conduits, electrical cables, and telephone cables. Yellow ribbon shall be used for all buried pipelines.

Ribbon shall be tape manufactured by Reef Industries or Allen Markline or equal and shall have metal foil which is completely encased in plastic and can be easily detected by metal detectors.

The ribbon shall be printed with the manufacturer's standard wording, "CAUTION ELECTRIC LINE BURIED BELOW," for all electrical conduits, phone lines, etc., "CAUTION BURIED PIPELINE BELOW," for all buried pipelines.

TRENCH STABILIZATION MATERIAL:

Granular material from the excavation or stockpile meeting the requirements of structural fill as specified in Section 02315, FILL AND BACKFILL.

PIPE BEDDING:

Pipe bedding material for thermoplastic pipe shall be clean sand/gravel mixture free from organic matter and conforming to the following gradation:

Sieve Size	Percent Passing
3/4″ square	100
3/8″ square	70-100
U.S. No. 4	55-100
U.S. No. 10	35-95
U.S. No. 20	20-80
U.S. No. 40	10-55

Sieve Size	Percent Passing
U.S. No. 100	0-10
U.S. No. 200	0-3

All percentages are by weight.

PIPE ZONE MATERIAL:

Excavated granular material from required excavations, free from rocks, roots, and organic matter. The maximum particle size shall be 3/4 inch and the percent by weight passing the No. 200 U.S. sieve shall be a maximum 15 percent.

Pipe bedding may be used as substitute for pipe zone material.

EARTH BACKFILL:

Earthfill as specified in Section 02315, FILL AND BACKFILL.

STRUCTURAL FILL:

As specified in Section 02315, FILL AND BACKFILL.

SOURCE QUALITY CONTROL:

As specified in Section 02315, FILL AND BACKFILL.

PART 3--EXECUTION

TRENCH PREPARATION:

Water Control:

Promptly remove and dispose of water entering trench as necessary to grade trench bottom and to compact backfill and install manholes, pipe, conduit, direct-buried cable, or duct bank. Do not place concrete, lay pipe, conduit, direct-buried cable, or duct bank in water.

Remove water in a manner that minimizes soil erosion from trench sides and bottom.

Provide continuous water control until trench backfill is complete.

Remove foreign material and backfill contaminated with foreign material that falls into trench.

TRENCH BOTTOM:

Firm Subgrade: ~~Grade with hand tools, remove~~ Remove loose and disturbed material~~,~~ and trim off high areas and ridges left by excavating equipment. ~~bucket teeth.~~ Tamp to provide a firm and unyielding subgrade. ~~with handheld equipment.~~ Allow space for bedding material if shown or specified.

Soft Subgrade: If subgrade is encountered that may require removal to prevent pipe settlement, notify Engineer. Engineer will determine depth of overexcavation, if any, required.

TRENCH STABILIZATION MATERIAL INSTALLATION:

Rebuild trench bottom with trench stabilization material.

Place material over full width of trench in 8-inch maximum, loose measurement lifts to required grade, providing allowance for bedding thickness.

Compact each lift so as to provide a firm, unyielding support for the bedding material prior to placing succeeding lifts.

BEDDING:

Place over the full width of the prepared trench bottom in two equal lifts when the required depth exceeds 8 inches.

Hand grade and compact each lift to provide a firm, unyielding surface.

Minimum Compacted Thickness: As shown on the Drawings. For leachate collection and riser pipes, there shall be no bedding between lining system and pipe.

Direct-Buried Cable: 3 inches.

Duct Banks: 2 inches.

Check grade and correct irregularities in bedding material.

BACKFILL PIPE ZONE:

Upper limit of pipe zone shall not be less than following:

Pipe: 12 inches, unless shown otherwise.

Conduit: 3 inches, unless shown otherwise.

<u>Direct-Buried Cable:</u> 3 inches, unless shown otherwise.

<u>Duct Bank:</u> 3 inches, unless shown otherwise.

Restrain pipe, conduit, cables, and duct banks as necessary to prevent their movement during backfill operations.

Place pipe zone material simultaneously in lifts on both sides of pipe and, if applicable, between pipes, conduit, cables, and duct banks installed in same trench.

<u>Pipes 10 Inches and Smaller Diameter:</u> First lift less than or equal to 1/2 pipe-diameter.

<u>Pipes Over 10-Inch Diameter:</u> Maximum 8-inch, loose measurement lifts.

Thoroughly tamp each lift, including area under haunches, with handheld tamping bars supplemented by "walking in" and slicing material under haunches with a shovel to ensure that voids are completely filled before placing each succeeding lift.

After the full depth of the pipe zone material has been placed as specified, compact the material by a minimum of three passes with a vibratory plate compactor only over the area between the sides of the pipe and the trench walls.

Do not use power-driven impact compactors to compact pipe zone material.

<u>LOCATOR RIBBON INSTALLATION:</u>

Continuously install locator ribbon along centerline of all buried piping, at depth of 16 inches below ground surface unless shown otherwise on the Drawings. Coordinate with piping installation drawings.

<u>BACKFILL ABOVE PIPE ZONE:</u>

<u>General:</u>

Do not allow backfill to free fall into the trench or allow heavy, sharp pieces of material to be placed as backfill until after at least 2 feet of backfill has been provided over the top of pipe. Trench backfill using water settling methods for compaction is not permitted.

Do not use power driven impact type compactors for compaction until at least 2 feet of backfill is placed over top of pipe. Hand-held jumpjack type compactors are acceptable for compaction of backfill over top of pipe.

Backfill to grade with proper allowances for topsoil, road gravel subbase, and pavement thicknesses, wherever applicable.

Backfill around structures with same backfill as specified for adjacent trench unless otherwise shown or specified.

Backfill Outside the Limits of Roadways, Utilities, and Other Facilities:

Place earthfill in lifts not exceeding 12-inch maximum, loose measurement thickness.

Mechanically compact each lift to a minimum of 90 percent relative compaction prior to placing succeeding lifts.

Backfill Under Facilities, Roadways, and Utilities: Backfill trench above the pipe zone with structural fill in lifts not exceeding 8 inches maximum, loose measurement thickness. Compact each lift to a minimum of 95 percent relative compaction prior to placing succeeding lifts.

REPLACEMENT OF TOPSOIL:

Where applicable, replace topsoil in top 6 inches of backfilled trench.

Maintain the finished grade of topsoil even with adjacent area and grade as necessary to restore drainage.

DRAIN GRAVEL BACKFILL FOR LEACHATE COLLECTION (SLOTTED) PIPE, RISER PIPES, AND SUMPS:

Use drain gravel as specified in Section 02315, FILL AND BACKFILL.

Drain gravel shall be placed in sumps by mechanical or hand methods that will not damage pipes or underlying geosynthetics. For areas within 3 feet of leachate collection or riser pipe centerline, the Construction General Contractor shall place drain gravel on both sides of pipe in 6-inch lifts. The Construction General Contractor shall thoroughly tamp each lift, including area under haunches with handheld equipment and tools to ensure that voids are completely filled before placing each succeeding lift. After the full depth of material has been placed as specified, the Construction General Contractor shall compact the material by a minimum of three passes with a hand-held vibratory plate compactor only over the area within 3 feet of pipe centerline. At all other locations, drain gravel shall be track-walked into place with a minimum two passes with a D6M-LGP bulldozer or equal. Equipment limitations and requirements for placing materials over geosynthetics is specified in Section 02315, FILL AND BACKFILL.

BACKFILL FOR GEOSYNTHETIC ANCHOR TRENCHES:

Backfill with material as shown on the Drawings in loose lifts not exceeding 6 inches in thickness and compact using hand-operated equipment to not less than 90 percent relative compaction.

CONSTRUCTION QUALITY CONTROL:

The Construction General Contractor shall perform in-place density and moisture content tests as specified in Section 02315, FILL AND BACKFILL, to be observed by the Construction Manager, on the following minimum schedule:

Backfill Above Pipe Zone: One per 500 linear feet per lift.

MAINTENANCE OF TRENCH BACKFILL:

After each section of trench is backfilled, maintain the surface of the backfilled trench even with the adjacent ground surface until final surface restoration is completed.

Topsoil: Add topsoil where applicable and as necessary to maintain the surface of the backfilled trench level with the adjacent ground surface.

Other Areas: Add excavated material where applicable and keep the surface of the backfilled trench level with the adjacent ground surface.

SETTLEMENT OF BACKFILL:

Settlement of trench backfill, or of fill or facilities constructed over trench backfill will be considered a result of defective compaction of trench backfill.

END OF SECTION 02320

SECTION 02632--STORMWATER PIPING

PART 1--GENERAL

REFERENCES:

The following is a list of standards which may be referenced in this section and any supplemental Data Sheets:

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M294	Standard Specifications for Corrugated Polyethylene Pipe, 300- to 1200-mm Diameter

ASTM INTERNATIONAL (ASTM)

ASTM F477	Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

SUBMITTALS–APPROVAL NOT REQUIRED:

Information/Record (IR):

Catalog and manufacturer's data sheets for stormwater pipe and fittings.

PART 2--PRODUCTS

PIPE AND FITTINGS:

Pipe and fittings for culverts and stormwater pipes shall be corrugated polyethylene (CPE) in accordance with the following:

Item	Description
Pipe	AASHTO M294
Pipe Stiffness (Minimum)	In accordance with specified AASHTO Specification.
Profile	Type S.
Joints	Bell and spigot, gasketed type and water-tight.
Gaskets	ASTM F477.
Fittings	Manufacturer's standard; same stiffness as adjacent pipe.
Source Quality Control	In accordance with specified AASHTO Specification.

Item	Description
Factory Testing	Pipe lengths used for deflection testing shall be destroyed after testing.

PART 3--EXECUTION

INSTALLATION OF PIPE, FITTINGS, AND APPURTENANCES:

General:

Pipe laying shall proceed upgrade with spigot ends pointing in direction of flow.

Excavate bell holes at each joint to permit correct assembly and inspection of entire joint.

Pipe invert may deviate from line or grade up to 1/2 inch for line and 1/4 inch for grade, provided that finished pipe line will present a uniform bore, and such variation does not result in a level or reverse sloping invert, or less than minimum slope shown.

Pipe bedding shall form continuous and uniform bearing and support for pipe barrel between joints. Pipe shall not rest directly on bell or pipe joint.

Prevent entry of foreign material into gasketed joints.

Plug or close off pipes that are stubbed off for manhole, concrete structure, or for connection by others, with temporary watertight plugs.

Trench excavation and placement of pipe bedding and pipe zone materials shall be in accordance with Section 02320, TRENCH BACKFILL.

Any excavation safety systems shall be in accordance with Section 02316, EXCAVATION.

PIPE CLEANING:

Prior to final acceptance and final inspection of the stormwater pipes by Construction Manager,~~Engineer,~~ flush and clean all stormwater pipes and catch basins. Remove all accumulated construction debris, rocks, gravel, sand, silt, and other foreign material. If necessary, use mechanical rodding or bucketing equipment.

Upon Construction Manager's ~~Engineer's~~ final inspection of the stormwater pipes, if any foreign matter is still present in the system, reflush and clean the sections and portions of the lines as required.

END OF SECTION 02632

SECTION 02661--GEOMEMBRANES

PART 1--GENERAL

REFERENCES:

The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D638	Standard Test Method for Tensile Properties of Plastics
ASTM D1004	Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting
ASTM D1238	Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer
ASTM D1505	Standard Test Method for Density of Plastics by the Density-Gradient Technique
ASTM D1603	Standard Test Method for Carbon Black in Olefin Plastics
ASTM D4218	Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
ASTM D4833	Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
ASTM D5199	Standard Test Method for Measuring the Nominal Thickness of Geosynthetics
ASTM D5321	Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method
ASTM D5397	Evaluation of Stress Crack Resistance of Polyolefin Geomembrane Using Notched Constant Tension Load Test (Appendix A, Single Point)
ASTM D5596	Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
ASTM D5994	Standard Test Method for Measuring Core Thickness of Textured Geomembranes
ASTM D6243	Standard Test Method for Determining the Internal and Interface Shear Resistance of Geosynthetic Clay Liner by the Direct Shear Method
ASTM D6392	Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods

GEOSYNTHETIC RESEARCH INSTITUTE (GRI)

GRI-GM12	Asperity Measurement of Textured Geomembranes Using a Depth Gage
GRI-GM13	Test Properties, Testing Frequency and Recommended Warranty for High Density Polyethylene (HDPE) Smooth and Textured Geomembrane

DESCRIPTION:

The Work includes IDF manufacture, fabrication (if needed), supply, and installation of geomembrane for the lining system, and for other geomembrane applications, as shown on the Drawings. Geomembrane is also referred to as flexible membrane liner (FML).

DEFINITIONS:

CQA Certifying Engineer: Engineer providing independent oversight and responsible for implementing the CQA Plan. Independent is defined as an organization that operates separately from the Construction General Contractor, DOE-ORP, and the Tank Farm Contractor.

Engineer: Design Engineer for the IDF, providing technical design support during construction.

Construction Manager: Construction coordinator overseeing the IDF construction activities in the field and the Tank Farm Contractor's onsite technical representative.

Construction General Contractor: Responsible for overall construction activities and operations, including Construction Subcontractors.

Installer: Construction Subcontractor responsible for installation of geosynthetics (geomembrane, GCL, CDN, and geotextiles).

LCRS: Leachate collection and removal system.

LDS: Leak detection system.

SLDS: Secondary Leak Detection System.

SUBMITTALS–APPROVAL REQUIRED:

See Section 01300, SUBMITTALS, for submittal procedures.

Manufacturer's descriptive data, specification sheets, literature, and other data as necessary to fully demonstrate that those materials proposed for use comply with the requirements of these Specifications.

Construction General Contractor shall submit required interface strength data as specified in PART 2--PRODUCTS prior to shipment of material to allow Engineer to evaluate if submitted material meets strength requirements for project design criteria. Allow Engineer 20 working days for this evaluation upon receipt of data.

Installation Plan: The Construction General Contractor shall submit an installation plan describing the proposed methods for geomembrane deployment, panel layout, seaming, repair, and protection. The installation plan shall provide for no field seam locations within the LCRS sump trough under the leachate collection and riser pipes. Construction General Contractor shall orient panel layout such that one full panel width spans the LCRS sump trough. The plan shall also include a quality control program for the Construction General Contractor's activities related to geomembrane installation.

Manufacturer's Quality Control (QC) test data for geomembrane composition and properties as specified in paragraph MANUFACTURING QUALITY CONTROL - POLYETHYLENE GEOMEMBRANES.

Manufacturer's QC certification as specified herein.

The Construction General Contractor shall submit Geomembrane Installer's organizational and seaming personnel qualifications, and other as required to provide the information described in these Specifications.

The Construction General Contractor shall submit Geomembrane Installer's Certificate of Subgrade Acceptability to the CQA Certifying Engineer as specified herein.

Calibration certification for construction quality control test equipment.

SUBMITTALS–APPROVAL NOT REQUIRED:

Information/Record (IR):

Documentation of test results from construction quality control testing.

CONSTRUCTION QUALITY ASSURANCE (CQA):

CQA Plan: A CQA Plan has been prepared as part of the landfill design. The CQA Plan discusses the testing procedures that will be followed by the CQA Certifying Engineer during installation of the geosynthetics (geotextile, CDN, geomembrane, GCL) and the documentation of the process. The CQA Plan is made part of these Specifications by reference. The Construction General Contractor shall conform to the requirements of the

CQA Plan for all aspects of the geosynthetics, including submittals, supply, storage, installation, testing, documentation, covering, and protection.

Quality assurance procedures are presented in the CQA Plan. The Construction General Contractor shall accommodate all quality assurance activities described in this section and in the CQA Plan for this project.

Prior to placing any materials over the installed geomembrane, the Construction General Contractor shall allow time for acceptance of the Work as listed in the CQA Plan.

CQA CONFORMANCE TESTING:

Upon delivery of the rolls of geomembrane, the CQA Certifying Engineer will obtain samples at a frequency of one per production lot or one per 50,000 square feet of geomembrane, whichever results in greater number of tests. The CQA Certifying Engineer will test the samples to determine conformance to both the design specifications and the list of guaranteed properties.

As a minimum, tests to determine the following characteristics will be performed on geomembranes:

Thickness (ASTM D5994).

Tensile characteristics (yield strength, elongation at yield; ASTM D638).

Asperity (GM-12).

Puncture resistance (ASTM D4833).

Where optional procedures are noted in the test method, the requirements of these Specifications will prevail.

Sampling Procedures: Samples will be taken across the entire width of the roll and will not include the first 3 feet. Unless otherwise specified, samples will be 3 feet long by the roll width. The CQA Certifying Engineer will mark the machine direction on the samples with an arrow.

The CQA Certifying Engineer shall be allowed to remove samples for testing and other activities. Sample dimensions, procedures, and frequency shall be the same as those specified in the CQA Plan. The Construction General Contractor shall assist the CQA Certifying Engineer as necessary in all sampling and testing activities.

Procedures for samples that fail conformance testing are outlined in the CQA Plan. The cost of additional conformance testing to demonstrate compliance of failed samples shall be borne by the Construction General Contractor.

WARRANTY:

The geomembrane manufacturer(s) shall provide warranties on all geomembrane materials installed at the project site. The warranties shall be provided to the Construction General Contractor as purchaser with the Tank Farm Contractor named as beneficiary and shall be signed by an authorized representative of the geomembrane manufacturer. The terms of the warranties shall, at a minimum, include the provisions contained in the most recent version of GRI Test Method GM-13.

PART 2--PRODUCTS

GENERAL:

Type: High density polyethylene (HDPE). Unreinforced, 60-mil nominal thickness, textured both sides.

Manufacturer: The HDPE geomembrane manufacturer(s) shall have a minimum of 5 years of experience as a commercial manufacturer of HDPE geomembranes for landfill applications. Examples of potential manufacturers include: GSE Lining Technology, Inc., Houston, TX; and Poly-Flex, Inc., Grand Prairie, TX. Use of these examples is not intended to restrict potential manufacturers.

REQUIRED PROPERTIES - POLYETHYLENE GEOMEMBRANES:

Use of Recycled Polymer: The raw material shall be new polyethylene resin containing no more than two percent clean recycled polymer by weight. Two percent recycled polymer shall not include any finished sheet material that has actually seen some type of service performance. Regrind, reworked, or trim materials in the form of chips or edge strips that have not actually seen some type of use may be added, if the material is from the same manufacturer and is the same formulation as the geomembrane being produced.

Resin Properties: The resin shall meet the following Specifications:

HDPE:

Resin Specific Gravity (ASTM D1505): >0.932.

Melt Index (ASTM D1238 Condition 190/2.16): 0.1-1.1 g/10 min.

Finished Sheet Properties: The physical, mechanical, and environmental properties of the finished sheet shall meet or exceed the values specified in Table 1 contained in this part of the Specifications. Where applicable, values in Table 1 are Minimum Average Values.

Required Interface Shear Strength Data: Provide data prior to material shipment for the interface friction angle between the textured geomembrane and other materials (including CDN, GCL, and Admix Liner) directly in contact with the geomembrane as specified in

Article SUBMITTALS. Perform two interface shear strength tests on each interface under each set of normal loads.

Friction angle shall be determined by direct shear testing under fully saturated conditions (ASTM D5321 or D6243 for GCL interface) at both low normal loads of 100, 250, and 500 pounds per square foot (psf), and high normal loads of 2,000, 8,000, and 15,000 psf. Report results for both peak and large displacement (minimum 2 inches) strength.

The Engineer will review this data for conformance with project strength requirements. Construction General Contractor shall not order material for shipment until approved by Engineer. Any product or material changes required as a result of inadequate strength data will be addressed by Change Order provided submitted material meets all other requirements of this section.

<u>MANUFACTURING QUALITY CONTROL - POLYETHYLENE GEOMEMBRANES:</u>

<u>Quality Control Testing:</u> Quality control testing shall be carried out by the manufacturer to demonstrate that the geomembrane meets the Specifications in this section. Additional testing may be carried out for purposes of determining conformance by the CQA Certifying Engineer. If the results of the manufacturer's and the CQA Certifying Engineer's testing differ significantly, the testing shall be repeated by the CQA Certifying Engineer, and the manufacturer shall be allowed to monitor this testing. The results of this latter series of tests will prevail, provided that the applicable test methods have been followed.

<u>Required Information:</u> Prior to the delivery of any geomembrane material, the manufacturer shall submit the following information:

The origin (resin supplier's name, resin production plant), identification (brand name, number), and production date of the resin.

A list of quantities and descriptions of materials other than the base polymer which comprise the geomembrane.

Copies of the quality control certificates issued by the resin supplier.

Reports on the tests conducted by the manufacturer to confirm that the quality of the resin used to manufacture the geomembrane satisfies these Specifications.

A statement that recycled polymer (if any) is clean and does not exceed 2 percent by weight.

A properties sheet including, at a minimum, all specified properties, measured using test methods indicated in these Specifications, or equivalent.

Reports on the tests, including sampling procedures, conducted by the manufacturer to confirm that the geomembrane meets the Specifications.

A certification that property values given in the properties sheet are guaranteed by the geomembrane manufacturer.

<u>QC Certification:</u> Prior to shipment, the geomembrane manufacturer shall provide a quality control certificate for each roll of geomembrane. The quality control certificate shall be signed by a responsible party employed by the geomembrane manufacturer, such as the production manager. The quality control certificate shall include:

Roll numbers and identification, resin lot, and batch numbers.

Sampling procedures and results of quality control tests. As a minimum, results shall be given for thickness, asperity, tensile strength, and tear resistance in accordance with methods indicated in these Specifications. Tests shall be conducted on each production lot of geomembrane or every 50,000 square feet, whichever results in the greater number of tests.

<u>Manufacturing Plant Visit:</u> The manufacturer shall allow the CQA Certifying Engineer or his designated representative to visit the manufacturing plant, if the CQA Certifying Engineer so chooses. If possible, the visit shall be prior to or during the manufacturing of the geomembrane rolls for the specific project. The CQA Certifying Engineer or his designated representative shall review the manufacturing process, quality control, laboratory facilities, and testing procedures. During the visit, visiting personnel will also:

Confirm that the measurements of properties by the manufacturer are properly documented and test methods used are acceptable.

Spot inspect the rolls and confirm that they are free of holes, blisters, or any sign of contamination by foreign matter.

Review packaging and transportation procedures to confirm that these procedures are not damaging the geomembrane.

Confirm that roll packages have a label indicating the name of the manufacturer, type of geomembrane, thickness, and roll number.

If applicable, confirm that extrusion rods and/or beads are derived from the same base resin type as the geomembrane.

The geomembrane manufacturer shall accommodate these activities.

<u>EXTRUDATE:</u>

<u>Extrudate for Fusion Welding of HDPE Geomembrane:</u> Formulated from same HDPE resin as geomembrane and shall meet applicable physical property requirements.

FIELD-FABRICATED BOOTS:

Pipes and other structures penetrating the lining system shall be sealed to the geomembrane with fabricated boots made of the same material and workmanship as the lining system geomembrane. The flange portion of each boot shall match the angle of the slope or bottom, be sealed to the geomembrane, and fit smoothly without folds or stretching of the material.

SEALANT CAULKING:

Where shown on the Drawings, the caulking used shall be a one-component sealant formulated of butyl rubber and other selected ingredients, equivalent to Biddle Co., St. Louis, MO, Butylgrip Sealant, or as recommended by the manufacturer of the geomembrane materials.

STAINLESS STEEL CLAMPS:

As indicated on the Drawings, clamps shall be used to secure the HDPE geomembrane to pipes, poles, or risers that are intended to protrude through the cover. One-half-inch wide clamps shall meet or exceed specifications for "Make-a-Clamp" as manufactured by Breeze Clamp Products Division, Federal Laboratory, Inc., Saltsburg, PA.

BUTYL MASTIC TAPE:

Shall be as manufactured by Tremco, Cleveland, OH; or of a type recommended by HDPE geomembrane manufacturer.

NEOPRENE RUBBER PAD:

As indicated on the Drawings, neoprene rubber shall be used as compression strip beneath the stainless steel clamps (ASTM D2240). One-half-inch thick neoprene rubber shall be 35 to 40 durometer hardness, as supplied by Aero Rubber Co., Inc., Bridgeview, IL, or approved equal. Cut to a continuous 2-inch wide piece of neoprene to form the gasket. Neoprene rubber contact cement recommended by the supplier shall be used to bond butt ends of joined strips and to bond neoprene rubber in position on surface. Butt joints in neoprene strips shall be offset from adjacent joints by at least 6 inches.

TENSIOMETER FOR FIELD TESTING:

Motor driven with jaws capable of traveling at measured rate of 2 inches per minute. Equipped with gauge which measures force in unit pounds exerted between jaws.

PLYWOOD SHEETING:

Use APA rated sheeting EXT for protection of the HDPE geomembrane at termination edges on south side of Phase I.

PART 3--EXECUTION

GENERAL:

Personnel Qualifications - Polyethylene Geomembranes:

Installer Organization: At a minimum, the Construction General Contractor organization shall have successfully completed at least five projects consisting of installation of at least 5,000,000 square feet (total) of HDPE liner. Projects shall include RCRA landfills.

Seaming Personnel: All personnel performing seaming operations shall be qualified by experience or by successfully passing seaming tests similar to those described in this section. The superintendent and lead welder foreman shall have experience seaming a minimum of 1,000,000 square feet of polyethylene geomembrane using the same type of seaming apparatus proposed for use on this project. These individuals shall provide direct supervision over less experienced seamers. No field seaming shall take place without one of these individuals being present. Key personnel are defined as the superintendent, foreman, and lead welder. Key personnel shall be full time employees of the Geosynthetics Installer.

Applicability: The primary and secondary geomembranes shall be installed at the locations, lines, and grades shown on the Drawings. All geomembranes shall be installed in accordance with these Specifications and the CQA Plan.

Installation Plan: Prior to beginning geomembrane installation, the Construction General Contractor shall submit a plan describing the proposed size, number, position and sequence of geomembrane panel placement, and location of field seams.

~~SOIL-BENTONITE LINER~~ SUBGRADE SURFACE PREPARATION - POLYETHYLENE GEOMEMBRANES:

The Construction General Contractor shall be responsible for preparing the subgrade surface ~~of the soil bentonite liner~~ for the geomembrane. Prepare the underlying soil surface as specified in Section 02319, SUBGRADE PREPARATION, and as approved by the Geomembrane Installer.

The Geomembrane Installer shall certify in writing that the surface on which the geomembrane will be installed is acceptable. The certificate of acceptance shall be given by the Installer to the Construction General Contractor prior to commencement of geomembrane installation in the area under consideration. The CQA Certifying Engineer shall be given a copy of this certificate by the Construction General Contractor. The form for Geomembrane Installer certification is provided as Supplement to this Specification. Submittal of this form only applies to soil surfaces underlying the geomembrane. In this case Geomembrane Installer Certification of Subsurface Acceptability is only required for the surface on which the secondary and SLDS geomembrane shall be installed.

After the ~~admix liner~~ subgrade surface has been accepted by the Installer, it shall be the Installer's responsibility to indicate to the Construction General Contractor any change in the ~~admix liner~~ subgrade surface condition that may require repair work.

Special care shall be taken to avoid desiccation cracking or freezing of the ~~soil-bentonite~~ admix liner. Specifications for allowable desiccation cracking of soil liner and repair measures are contained in Section 02666, ADMIX LINER. The surface of the admix liner shall be maintained in the required condition throughout the course of geomembrane installation.

ANCHOR TRENCH EXCAVATION AND BACKFILLING:

The anchor trench shall be excavated to the lines and widths shown on the design Drawings, prior to geomembrane placement. The corners of the trench shall be rounded so as to avoid sharp bends in the geomembrane. No loose soil shall be allowed to underlie the geomembrane in the anchor trench. Backfill with material as shown on the Drawings and compact as specified in Section 02320, TRENCH BACKFILL.

GEOMEMBRANE PLACEMENT - POLYETHYLENE GEOMEMBRANES:

Field Panel Identification: A field panel is the unit area of geomembrane which is to be seamed in the field. Two cases are defined:

> If the geomembrane is fabricated into panels in a factory, a field panel is a factory panel or a portion of factory panel cut in the field.
>
> If the geomembrane is not fabricated into factory panels, a field panel is a roll or a portion of roll cut in the field.

It will be the responsibility of the CQA Certifying Engineer to assign each field panel an "identification code" (number or letter-number) consistent with the layout plan. This identification code shall be agreed upon by the Construction Manager, Installer, and CQA Certifying Engineer. This field panel identification code shall be as simple and logical as possible. (Note that roll numbers assigned in the manufacturing plant are usually cumbersome and are not related to location in the field.)

The CQA Certifying Engineer will establish a table or chart showing correspondence between roll numbers, factory panels, and field panel identification codes. The field panel identification code shall be used for all quality assurance records, including Installer's quality control (QC) testing.

Field Panel Placement:

> Location: Field panels shall be installed at the locations indicated in the Installer's layout plan, as approved or modified.

Installation Schedule: In general seaming of geomembrane will be performed the same day as deployment. However, at the discretion of Geosynthetic Installer, seaming may be carried over to the following workday.

Placement Conditions: Geomembrane placement shall not proceed at an ambient temperature below 32 degrees F or above 104 degrees F as measured 6 inches above the geomembrane surface unless installation procedures approved by the CQA Certifying Engineer are in place to address environmental conditions. Geomembrane placement shall not be done during any precipitation, in the presence of excessive moisture (e.g., fog, dew), in an area of ponded water, or in the presence of excessive winds. Placement methods shall prevent damage to underlying soil liner or geosynthetic materials.

Factors such as expansion, contraction, overlap at seams, anchorage requirements, seaming progress, and drainage shall be considered. Textured-surface sheets shall be aligned in a manner which maximizes their frictional capabilities along the slope. Maneuver sheets of geomembrane into place in a manner which prevents wrinkles, folds, or similar distress which can damage the geomembrane or prevent its satisfactory alignment or seaming. A smooth-surface HDPE geomembrane rub sheet shall be used when placing textured HDPE geomembrane over underlying GCL. The rub sheet shall be maintained in good condition without tears, rough edges, holes, or scuff marks that can catch, displace, or otherwise disturb the underlying GCL, or the overlying geomembrane.

Damage: Damaged panels or portions of damaged panels which have been rejected shall be removed from the work area. Any repairs shall be made according to procedures described in this Part of the Specifications.

Exposed Geomembrane Protection: After panel deployment, all geomembrane, except those shown as permanently exposed on the Drawings, shall be covered to within a maximum period of 10 working days to minimize exposure to temperature cycles that cause expansion/ contraction of the geomembrane and desiccation of the underlying admix liner. Geomembrane panels shall be covered by other geosynthetic components of the lining system or overlying soil cover materials as shown on the Drawings.

FIELD SEAMING - POLYETHYLENE GEOMEMBRANES:

Seaming Equipment and Products: Approved processes for field seaming are extrusion welding and fusion welding, except that use of extrusion welding shall be limited to areas (such as sumps or repairs) where fusion welding cannot be employed. Proposed alternate processes shall be documented and submitted by the Installer to the Construction Manager and CQA Certifying Engineer for approval. Only equipment which has been specifically approved by make and model shall be used.

Extrusion Process: The extrusion-welding machine shall be equipped with gages capable of measuring the temperature at the nozzle or the preheat temperature.

The Installer shall provide documentation regarding the extrudate and shall certify that the extrudate is compatible with these Specifications and is comprised of the same resin type as the geomembrane sheeting.

The Installer shall comply with the following:

The Installer shall maintain on-site a sufficient number of spare operable seaming machines (at least one at all times) to ensure continuous operation.

The equipment used for seaming shall not be likely to damage the geomembrane.

The extruder shall be purged prior to beginning a seam until all heat-degraded extrudate has been removed from the barrel.

The electric generator shall be placed on a smooth base such that no damage occurs to the geomembrane.

Grinding shall be completed no more than 1 hour prior to seaming. A smooth insulating plate or fabric shall be placed beneath the hot welding machine after usage.

The geomembrane shall be protected from damage in heavily trafficked areas.

Fusion Process: The fusion-welding machines shall be automated vehicular-mounted devices. The fusion-welding machines shall be equipped with gages giving the pertinent temperatures.

The Installer shall comply with the following:

The Installer shall maintain on site a sufficient number of spare operable seaming machines (at least one at all times) to ensure continuous operations.

The equipment used for seaming shall not be likely to damage the geomembrane.

~~For cross seams, the edge of the cross seam shall be ground to a smooth incline (top and bottom) prior to welding.~~

The electric generator shall be placed on a smooth base such that no damage occurs to the geomembrane.

A smooth insulating plate or fabric shall be placed beneath the hot welding machine after usage.

The geomembrane shall be protected from damage in heavily trafficked areas.

If a build-up of moisture is observed prior to seaming a movable protective layer shall be used directly below each overlap of geomembrane to be seamed to prevent buildup of moisture between the sheets.

Seam Layout:

In general, seams shall be oriented parallel to the line of maximum slope, i.e., oriented up and down, not across, the slope to the maximum extent practical. In corners and odd-shaped geometric locations, the number of seams shall be minimized. No seams shall be permitted within the LCRS sump trough for leachate collection and riser pipes. One full panel width shall span the LCRS sump trough.

On the landfill floor:

No horizontal seam shall be less than 5 feet from the toe of the slope, or other area of potential stress concentrations.

Over the LCRS, ~~and~~ LDS, and SLDS sump areas in each cell, no horizontal seam shall be placed less than 150 feet from the toe of the north slope for a distance of at least 100 feet in each direction from the LCRS and LDS sump centerline.

Seams shall be aligned to produce the fewest possible number of wrinkles and "fishmouths."

A seam numbering system consistent with the panel numbering system shall be utilized.

Weather Conditions for Seaming: The allowable weather conditions for seaming are as follows:

Unless authorized in writing by the Construction Manager, no seaming shall be attempted at ambient temperatures below 32 degrees F or above 104 degrees F as measured 6 inches above the geomembrane surface.

The geomembrane shall be dry, protected from wind, and free of dust.

If the Installer wishes to use methods which may allow seaming at ambient temperatures below 32 degrees F, the Installer shall certify in writing that the quality of the seams welded at these temperatures is the same as the quality of seams welded at temperatures above 32 degrees F. In addition, if the Installer wishes to seam at ambient temperatures below 32 degrees F, the following conditions shall be satisfied in addition to the general seaming procedures:

For extrusion welding, preheating shall be performed. Preheating may be waived by the Construction Manager if it is demonstrated to the satisfaction of the CQA Certifying Engineer that welds of equivalent quality may be obtained without preheating at the expected temperature of installation.

Sheet grinding, if required, may be performed before preheating.

Observe all areas of the geomembrane that have been preheated to determine that they have not been subjected to excessive melting.

Confirm that geomembrane surface temperatures have not decreased below the minimum specified for welding, due to wind or other adverse conditions. Wind protection for the seam area may be required.

Trial seams, as described in paragraph Trial Seams of this section, shall be made in the immediate area where seaming will occur, under the same ambient temperature and preheating conditions as the actual seams. New trial seams shall be made if the ambient temperature decreases by more than 5 degrees F from the previous trial seam conditions. Such new trial seams shall be conducted as soon as seams in progress during the temperature drop have been completed.

Additional destructive seam tests, as described in paragraph Destructive Seam Strength Testing of this section, shall be performed at intervals of 250 to 500 feet of seam length at the CQA Certifying Engineer's discretion.

The Installer shall provide sample coupons cut from each end of the seam.

Seam Preparation:

Cleaning: Prior to seaming, the seam area shall be clean and free of moisture, dust, dirt, debris of any kind, and foreign material. Special attention shall be paid to cleaning the existing geomembrane at tie-in locations.

Overlap: Cross slope seams on both the trench floor and sideslopes shall be overlapped so that liquids are not trapped, i.e., seams shall be shingled downslope. If seam overlap grinding is required, the process shall be completed according to the geomembrane manufacturer's instructions within 1 hour of the seaming operation, and in a way that does not damage the geomembrane. Panels of geomembrane shall have a finished overlap of a minimum of 3 inches for extrusion welding and 5 inches for fusion welding.

Use of Solvents: No solvent or adhesive shall be used.

Temporary Bonding: The procedure used to temporarily bond adjacent panels together shall not damage the geomembrane; in particular, the temperature of hot air at the nozzle of any spot welding apparatus shall be controlled such that the geomembrane is not damaged.

General Seaming Procedure: The general seaming procedure used by the Installer shall be as follows:

Seaming shall extend to the outside edge of panels to be placed in the anchor trench.

If required, a firm substrate shall be provided by using a flat board, a conveyor belt, or similar hard surface directly under the seam overlap to achieve proper support.

If seaming operations are carried out at night, adequate illumination shall be provided.

"Fishmouths" or wrinkles at the seam overlaps shall be cut along the ridge of the wrinkle in order to achieve a flat overlap. The cut "fishmouths" or wrinkles shall be seamed, and any portion where the overlap is inadequate shall then be patched with an oval or round patch of the same geomembrane extending a minimum of 6 inches beyond the cut in all directions.

CONSTRUCTION QUALITY CONTROL TESTING - POLYETHYLENE GEOMEMBRANES:

General: Testing requirements specified herein are intended for the Construction General Contractor (and Geomembrane Installer) during geomembrane installation. Testing requirements for the CQA Certifying Engineer are provided in the CQA Plan.

Trial Seams: Trial seams shall be made on fragment pieces of geomembrane liner to verify that seaming conditions are adequate. A trial seam shall be made prior to each seaming period (maximum of 6 hours) for each seaming machine used that day. Also, each seamer shall make at least one trial seam each day. Trial seams shall be made under the same conditions as actual seams.

The trial seam sample shall be at least 2 feet long by 1 foot wide (after seaming) with the seam centered lengthwise. Seam overlap shall be as indicated in this Part.

Test three specimens for peel and two specimens for shear. Each specimen shall be at least 1 inch wide and shall be cut from the trial seam sample by the Installer. The specimens shall be tested respectively in shear and peel using a field tensiometer, and they shall not fail in the seam. All trial seam specimens must meet the minimum requirements of Table 2, Required Seam Properties, for trial seam acceptance. If a specimen fails, the entire operation shall be repeated. If the additional specimen fails, the seaming apparatus and seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful full trial seams are achieved.

All test equipment shall be in calibration and conform to manufacturer's specifications. The Installer shall provide the Construction Manager and CQA Certifying Engineer with current calibration certificates.

<u>Nondestructive Seam Continuity Testing:</u>

<u>General:</u> The Installer shall nondestructively test all field seams over their full length using a vacuum test unit, air pressure test (for double fusion seams only), or other approved method (i.e., spark test). Vacuum testing and air pressure testing are described below. The purpose of the nondestructive test is to check the continuity of seams. It does not provide any information on seam strength. Continuity testing shall be done as the seaming work progresses. Nondestructive testing will not be permitted before sunrise or after sunset unless the Construction General Contractor demonstrates to the CQA Certifying Engineer their capability to perform testing under reduced light conditions. Any seams which fail nondestructive testing shall be repaired in accordance with these Specifications. Seams which cannot be nondestructively tested because of seam geometry shall be double welded or capped.

All test equipment shall be in calibration and conform to manufacturer's specifications. The Installer shall submit current calibration certificates.

<u>Vacuum Testing:</u> The equipment shall be comprised of the following:

A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, port hole or valve assembly, and a vacuum gage.

A steel vacuum tank and pump assembly equipped with a pressure controller and connections.

A rubber pressure/vacuum hose with fittings and connections.

A bucket and wide paint brush.

A soapy solution.

The following procedures shall be used:

Energize the vacuum pump and reduce the tank pressure to a minimum of 5 inches of mercury.

Wet a strip of geomembrane approximately 12 inches wide by 48 inches long with the soapy solution.

Place the vacuum box over the test area.

Close the bleed valve and open the vacuum valve.

Ensure that a leak tight seal is created.

For a period of not less than 10 seconds, examine the geomembrane through the viewing window for the presence of soap bubbles.

If no bubbles appear coming from the seam after 10 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum 3-inch overlap, and repeat the process.

All areas where soap bubbles appear shall be marked and repaired in accordance with this Part.

Air Pressure Testing: The following procedures are applicable only to those processes which produce a double seam with an enclosed air channel. All double seams with an enclosed air channel shall be air pressure tested. The equipment shall be comprised of the following:

An air pump (manual or motor driven) capable of generating and sustaining a pressure of 60 to 65 psi.

A rubber hose with fittings and connections.

A sharp hollow needle, or other approved pressure feed device.

A calibrated pressure gage capable of reading pressures up to 65 psi.

The following procedures shall be used:

Seal both ends of the seam to be tested.

Insert needle with pressure gage, or other approved pressure feed device, into the air channel created by the fusion weld.

Energize the air pump and pressurize the channel to a minimum 25 psi for a 1/2-inch wide channel, or 55 psi for a 1-inch wide channel. Close the valve and sustain the pressure for a minimum of 5 minutes.

If loss of pressure exceeds 2 psi, or does not stabilize, locate faulty area and repair in accordance with this section. If significant changes in geomembrane temperature occur during the test (e.g., due to cloud cover), the test shall be repeated after the geomembrane temperature has stabilized.

Cut end of seam opposite to the pressure gage and observe that the pressure drops. If the pressure does not drop, locate the obstruction(s) in the seam, repair, and retest seam.

Remove needle or other approved pressure feed device and repair seam.

Destructive Seam Strength Testing:

General: Destructive seam tests shall be performed at selected locations. The purpose of these tests is to evaluate seam strength. Seam strength testing shall be done as the seaming work progresses. The samples shall meet the requirements of Table 2, Required Seam Properties.

All test equipment shall be in calibration and conform to manufacturer's specifications. The Installer shall submit current calibration certificates.

Each sample shall be tested for bonded seam shear and peel strength by an independent testing laboratory.

Test at least five specimens for each seam test method (shear and peel). Four out of five specimens must meet the minimum requirements of Table 2, Required Seam Properties, for field seam acceptance.

Location and Frequency: Destructive seam samples shall be obtained from actual fabricated field seams as work progresses, not at the completion of field seaming. The CQA Certifying Engineer will select locations where seam samples will be removed.

Sampling frequency shall be a minimum of one sample per 500 feet of seam length per welding machine (this minimum frequency shall be determined as an average taken from all the panels, including welds for caps), or a minimum of two samples per factory panel, whichever gives the largest number of samples. If agreed by all parties (Construction General Contractor, Construction Manager, and the CQA Certifying Engineer) the frequency of destructive seam testing may be reduced to one sample per 1,000 feet of seam if test results and other nondestructive seam tests appear adequate for assuring seam quality. If, based on the specified test frequency, a destructive test location should fall within the LCRS or LDS sump area (as shown on the

Drawings), the distance between destructive tests shall be reduced to relocate the destructive test location outside the sump area.

<u>Sampling Procedures:</u> Samples shall be cut by the Installer as the seaming progresses in order to provide laboratory test results before completion of installation. The CQA Certifying Engineer shall assign a number to each sample, mark it accordingly, and record the sample location on the layout drawing.

All holes in the geomembrane resulting from destructive seam sampling shall be immediately repaired in accordance with repair procedures. The continuity of the new seams in the repaired area shall be tested as described in this Part.

<u>Sample Size:</u> The samples shall be minimum 12 inches wide by minimum 42 inches long with the seam centered lengthwise. One 1-inch wide strip shall be cut from each end of the samples, and these shall be tested in the field as described below. The remaining sample shall be distributed as follows:

One portion (minimum 12 inches by 12 inches) to the Installer for laboratory testing at his discretion.

One portion (minimum 12 inches by 12 inches) to the Construction Manager for archive storage.

One portion (minimum 12 inches by 18 inches) to the CQA Certifying Engineer for laboratory testing.

<u>Field Testing:</u> The two 1-inch wide strips described above shall be tested in the field by tensiometer for peel and shear and shall not fail in the seam. If any test sample fails to pass, then the procedures outlined below (Procedures for Areas Failing Destructive Tests) shall be followed.

The CQA Certifying Engineer will mark all samples and portions with its number. The CQA Certifying Engineer will also record the date and time, ambient temperature, number of seaming unit, name of seamer, welding apparatus temperatures and pressures, and pass or fail descriptions, and attach a copy to each sample portion.

<u>Procedures for Areas Failing Destructive Tests:</u> The following procedures shall apply whenever a sample fails a destructive test, whether that test is conducted by the independent testing laboratory, the Installer's laboratory, or by field tensiometer. The Installer has two options:

The Installer shall cap the seam between any two passing test locations, or

The Installer shall trace the seam to two intermediate locations 10 feet minimum from the point of the failed test in each direction and take a small sample for an additional field test at each location. If these additional samples pass the test, then full samples shall be taken for laboratory testing. If these laboratory samples pass the tests, then the seam shall be capped between these locations. If either sample fails, then the sampling and testing process shall be repeated to establish the zone over which the seam shall be capped.

All acceptable capped seams shall be bounded by two locations from which samples passing CQA laboratory destructive tests have been taken. In cases where the length of the capped seam exceeds 150 feet, a sample of the capping seam shall be taken and shall pass destructive testing as described in this Part.

REPAIRS - POLYETHYLENE GEOMEMBRANES:

General: Any portion of the geomembrane exhibiting a flaw or failing a destructive or nondestructive test shall be repaired. All repairs shall be conducted in accordance with this Part. All repairs shall be subjected to the nondestructive seam testing procedures described in this Part.

Each patch or other type of repair will be numbered and recorded.

Repair Procedures:

Patching, used to repair large holes, tears, undispersed raw materials, and contamination by foreign matter.

Grinding and rewelding, used to repair small sections (typically with a maximum length of no more than several inches) of extruded seams.

Spot welding or seaming, used to repair pinholes.

Capping, used to repair large lengths of failed seams or areas where large wrinkles or fish mouths have been cut to flatten the geomembrane sheet.

Topping, used to repair areas of inadequate seams which have an exposed edge. Topping shall be limited to an aggregate length of no more than 3 m (10 feet) on any given seam.

Removing bad seam and replacing with a strip of new material welded into place, used with large lengths of fusion seams.

For all repair methods, the following provisions shall be satisfied as applicable:

Surfaces of the geomembrane which are to be repaired shall be abraded no more than one hour prior to the repair.

All surfaces shall be clean and dry at the time of the repair.

Patches or caps shall extend at least 6 inches beyond the edge of the defect, and all corners of patches shall be rounded with a radius of at least 3 inches.

The geomembrane below large caps shall be appropriately cut to avoid water or gas collection between the two sheets.

Verification of Repairs: Each repair shall be numbered and recorded. Each repair shall be nondestructively tested using the methods described in this Part. Large caps may be of sufficient extent to require destructive test sampling. Repairs that fail nondestructive or destructive tests shall be redone and retested until a passing test is obtained.

PROTECTION OF TERMINATION EDGES:

Along the south termination of the geomembrane, and along any termination edges of the membrane that may be exposed or buried for extended periods of time prior to their joining to adjacent subsequent sections, the Construction General Contractor shall protect leading edges with protective (sacrificial) layers of cushion geotextile and plywood sheet as shown on the Drawings.

MATERIALS IN CONTACT WITH GEOMEMBRANE:

The requirements of this Part are intended only to assure that the installation of other materials does not damage the geomembrane. Additional requirements as established in other sections of these Specifications are necessary to assure that systems built with these other materials are constructed in such a way as to provide proper performance. Material requirements for operations layer and drain gravel are specified in Section 02315, FILL AND BACKFILL.

Requirements of this Part apply to geomembranes that are directly in contact with overlying soil or are covered with a layer of geotextile or geocomposite.

Do not place granular materials in manner that will cause wrinkles to fold over or become confined to form a vertical ridge. Maximum wrinkle height shall be 4 inches and spacing between wrinkles shall be greater than 10 feet prior to placement of granular materials over the geomembrane.

Minimum Thickness: Equipment used for spreading granular material shall not be driven directly on the geomembrane. A minimum thickness of 1 foot of granular material shall be maintained between spreading equipment and the geomembrane. A minimum thickness of 3 feet of granular material shall be maintained between rubber-tired hauling vehicles and the geomembrane. Construction haul vehicles shall have a maximum ground contact pressure of 25 psi.

Spreading Equipment: Equipment used for spreading granular material shall be a light low ground pressure dozer (such as a wide-pad Caterpillar D6M LGP or lighter), low ground pressure excavator (Bucyrus-Erie 325H with 0.91-m [36-in] wide treads or lighter), or approved equal, with a maximum ground contact pressure of 5 psi.

Spreading Operations: Spreading equipment operating on soil materials shall not spin their tracks, make sharp turns, or make sharp, rapid starts or stops. Soil materials shall be pushed carefully from previously placed material and not dumped directly onto geosynthetics except for the drain gravel in the LDS sump and operations layer material in SLDS sump. ~~This material shall be carefully dumped onto the geotextile. Cushion from a maximum height of 24 inches.~~This material shall be carefully dumped onto the cushion geotextile or SLDS CDN from a maximum height of 24 inches.

The spreading operation on the sideslope (3H:1V) shall begin at the lower elevations and shall proceed either upslope or laterally at about the same elevation such that a full layer of granular material is always covering the geomembrane downslope from the area being covered. In no case shall the lift thickness be less than the stated minimum. Material shall be placed in such a manner that no air is trapped underneath the geomembrane. Provide and maintain a means of continuously observing the depth of granular materials such as by freestanding markers until placement is complete, at intervals of 50 feet maximum each way. Sharpened stakes or methods that could damage the geomembrane will not be allowed.

LINING SYSTEM ACCEPTANCE - POLYETHYLENE GEOMEMBRANES

The Installer shall retain all ownership of and responsibility for the geosynthetics in the lining system until acceptance by the Construction Manager.

The geosynthetic lining system will be accepted by the Construction Manager when all of the following requirements have been satisfied:

The installation is finished.

Verification of the adequacy of all field seams and repairs, including associated testing, is complete.

A written construction report, including "as built" drawings and all other installation documents, has been prepared by the CQA Certifying Engineer, sealed by a registered professional engineer, and received by the Construction Manager.

SUPPLEMENTS:

The supplements listed below, following "END OF SECTION," are a part of this Specification.

Table 1. Required Geomembrane Properties, 60-mil Textured HDPE.

Table 2. Required Seam Properties.

Geomembrane Installer's Certification of Subsurface Acceptability.

END OF SECTION 02661

Table 1. REQUIRED GEOMEMBRANE PROPERTIES 60-MIL TEXTURED HDPE

Property	Qualifier	Unit	Specified Value	Test Method
Physical Properties				
Thickness	min. avg. value	mils	60	ASTM D5994
	minimum		54	ASTM D5994
Specific Gravity	minimum	N/A	0.932	ASTM D1505
Melt Index	range	g/10 min	0.1-1.1	ASTM D1238 condition 190/2.16
Asperity	min avg. value[1]	mils	10	GRI-GM12
Mechanical Properties				
Tensile Properties (each direction)				ASTM D638 (Type IV)
Strength at yield	min. avg. value	lb/in	120	
Elongation at yield[2]	min. avg. value	%	12	
Tear Resistance	min. avg. value	lb	42	ASTM D1004
Puncture Resistance	min. avg. value	lb	80	ASTM D4833
Carbon Black Content	range	%	2-3	ASTM D1603 or D4218
Carbon Black Dispersion	minimum 8 of 10	category	1 or 2	ASTM D5596
Environmental Stress Crack	minimum[3]	hrs	200	ASTM D5397

[1]Of 10 readings, 8 out of 10 must be greater or equal to 7 mils, and lowest individual reading must be greater or equal to 5 mils. Provide data for both sides of textured geomembrane.
[2]Yield elongation is calculated using a gauge length of 1.3 inches.
[3]Minimum = mean minus 3 standard deviations from documented manufacturer's quality control (MQC) testing.

Table 2. REQUIRED SEAM PROPERTIES
HDPE GEOMEMBRANES

Property	Qualifier	Unit	Specified Value	Test Method
Shear Strength[1]	minimum	lb/in width	90% of tensile strength at yield as listed in tables in this section	ASTM D6392
Peel Adhesion	minimum	lb/in width	60% of tensile strength at yield as listed in tables in this section and FTB[2]	ASTM D6392

[1]Also called "Bonded Seam Strength."
[2]FTB = Film Tear Bond (failure occurs through intact geomembrane, not through seam).

GEOMEMBRANE INSTALLER'S CERTIFICATION OF SUBSURFACE ACCEPTABILITY

The geomembrane installer, ____ for the ~~Phase I~~ Integrated Disposal Facility (IDF), hereby certifies that the supporting prepared subgrade surfaces are acceptable for installation of the HDPE geomembrane lining system, the undersigned having personally inspected the condition of the constructed surfaces. This certification is for the areas shown on Attachment or defined as follows:

____

____

____

____

The condition of the supporting surfaces in the defined area meets or exceeds the minimum requirements for installation of the geomembrane.

Signed:____________________	Signed:____________________
Geomembrane Installer	Construction General Contractor
____________________	____________________
Date Signed	Date Signed

Replacement Construction Quality Assurance Plan for Appendix 4B, located in Volume 1 of 4

Integrated Disposal Facility (IDF) Detailed Design Cell 1 Construction Quality Assurance Plan

Prepared for

CH2M HILL Hanford Group

Richland, Washington

April 2004

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4/19/04

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This report was prepared under the supervision
of a registered professional engineer.

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Acronyms

ASTM	American Society for Testing and Materials
CDN	Composite drainage net
CM	Construction Manager
CQA	Construction Quality Assurance
CQC	Construction Quality Control
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
GCL	Geosynthetic clay liner
GRI	Geosynthetic Research Institute
IDF	Integrated Disposal Facility
LCRS	Leachate collection and removal system
LDS	Leak detection system
NCR	Non-Conformance Report
ORP	Office of River Protection
OSHA	Occupational Safety and Health Administration
PM	Project Manager
QA	Quality assurance
QC	Quality control
RFI	Request for Information
SBL	Soil bentonite admix liner
SLDS	Secondary leak detection system
UCL	Upper control limit
WAC	Washington Administrative Code

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SECTION I–GENERAL

1.1 INTRODUCTION

This Construction Quality Assurance (CQA) Plan describes the quality assurance (QA) activities for constructing Phase I of the Integrated Disposal Facility (IDF) at the Hanford facility in Richland, Washington.

1.1.1 Applicable Units

QA activities will be required during construction of Cell 1 of Phase I to certify that the following construction activities are performed in accordance with the construction documents:

- Construction/preparation of foundation systems for liners
- Construction of dikes or embankments
- Construction of low-permeability soil liners
- Construction of geomembranes
- Construction of leachate collection and removal systems and leak detection systems

This CQA Plan has been prepared to describe the activities that will be performed during construction of the lining system, leachate collection and leak detection systems, and operation layer of Cell 1. This CQA Plan is intended to satisfy the regulatory requirements and guidance established in 40 CFR 264.19, the U.S. Environmental Protection Agency's (EPA) technical guidance document, *Quality Assurance and Quality Control for Waste Containment Facilities* (EPA 1993), and Washington Administrative Code (WAC) 173-303-335.

This CQA Plan will be implemented by a CQA Officer (herein referred to as the CQA certifying engineer), a person familiar with EPA's technical guidance document, *Quality Assurance and Quality Control for Waste Containment Facilities* and this CQA Plan. The CQA certifying engineer will be supported by the number of CQA representatives necessary to implement the requirements in this CQA Plan and to document the work.

1.1.2 Scope

This CQA Plan establishes general administrative and documentation procedures that will be applicable for selected activities of construction. With respect to responsibilities, personnel qualifications, and specific inspection and testing activities, this CQA Plan addresses only those activities associated with the soils, geosynthetics, and related liner and leachate collection system piping components for the IDF.

The CQA requirements are divided into the following sections to provide quick access to CQA requirements for individual liner components:

- Soils CQA
- Geosynthetic Clay Liner CQA
- Geomembrane CQA
- Geotextile CQA
- Composite Drainage Net CQA
- Polyethylene Pipe and Fittings CQA
- CQA Documentation and Certification
- CQA Documentation and Certification

1.2 PROJECT ORGANIZATION

This section describes the anticipated project organization for the IDF construction activities. The following subsections address the organizations involved in the construction, their respective roles in construction activities, and the methods of interactions between organizations.

1.2.1 Responsibility and Authority

The organization chart for the IDF construction is shown in Figure 1-1. These personnel will be associated with two main entities that include the Tank Farm operating contractor and his agents and the construction general contractor and his personnel and/or subcontractors. The project team consists of both full-time field personnel and part-time management personnel. The part-time management personnel will be onsite during the IDF construction periodically to monitor progress, attend meetings, resolve disputes, and ensure that the work is implemented in accordance with the construction drawings, technical specifications, CQA Plan, and the RCRA permit. The field personnel will consist of the key personnel onsite during construction. The solid lines on the organization chart represent project responsibilities such as scope, cost, and schedule. The dashed lines represent the functional responsibilities of staff for QA, design, and management. The responsibilities and reporting requirements for each project team member are described in the following sections.

1.2.1.1 Project Team

When the individuals identified below are designated to perform specific functions described in this CQA Plan, the reference to these individuals includes their designee or an alternate who can function on their behalf. The Department of Energy – Office of River Protection (DOE-ORP) Manager is the owner's representative and is responsible for project funding and overall project scope. The DOE-ORP manager and IDF project manager keep the regulatory agencies informed of IDF construction activities and progress.

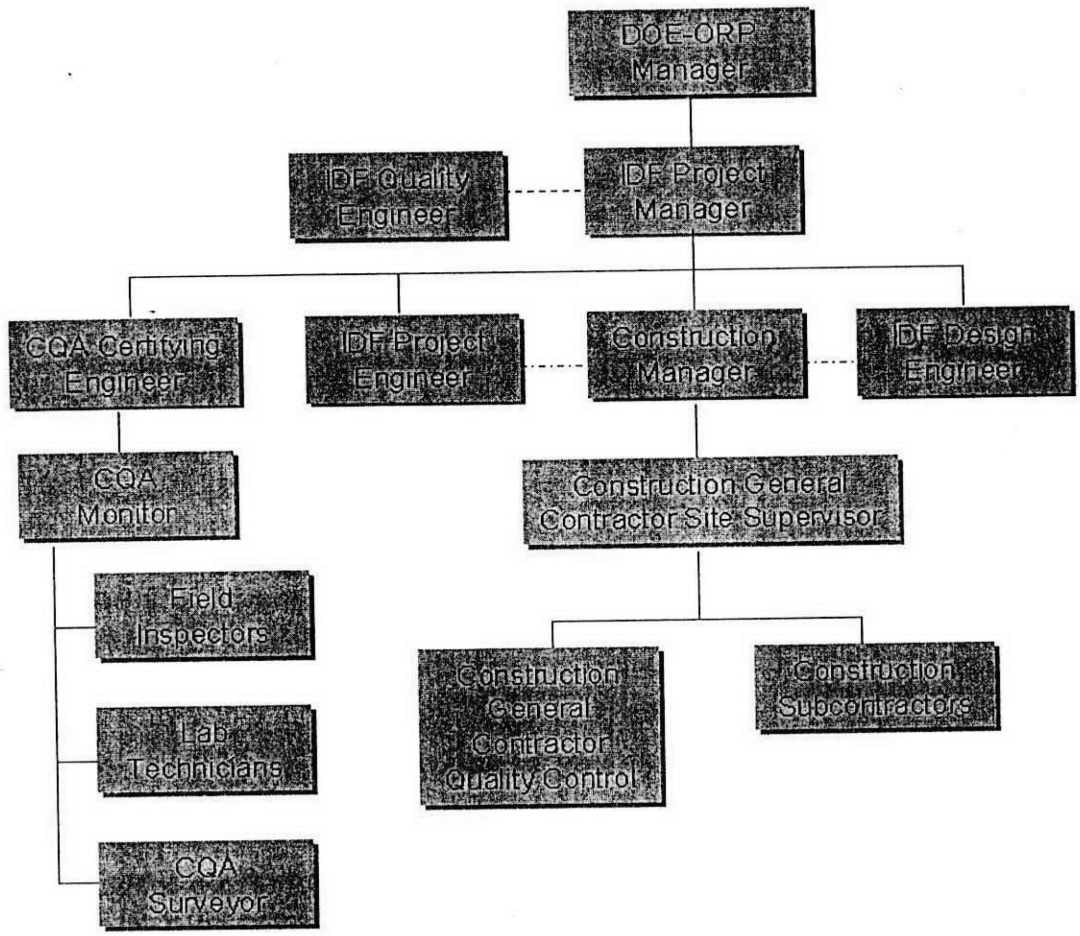
IDF Project Manager (PM)

The IDF PM is an employee or agent of the Tank Farm operating contractor, has overall responsibility for the IDF construction, and interfaces with the DOE-ORP manager. The IDF PM directs the activities of the IDF project and field team staff, including the CM, design engineer, and the project engineer. Additionally, the IDF PM has overall responsibility for the achievement of quality. Functionally, the IDF PM reviews and approves quality assurance reports submitted by the IDF CQA certifying engineer.

IDF Project Engineer

The IDF project engineer is an employee or agent of the Tank Farm operating contractor and is responsible for providing technical support to the IDF project team. The IDF project engineer is supported by the design engineer for reviewing and/or preparing technical documents related to engineering design and analyses.

FIGURE 1-1
QA Organization Chart



IDF Quality Engineer

The IDF quality engineer is an employee or agent of the Tank Farm operating contractor and is independent from line management on the project. The IDF quality engineer provides overview and assessment of QA on the project. The IDF quality engineer provides feedback and assessment results to the IDF PM.

IDF Design Engineer

The IDF design engineer is an employee or agent of the Tank Farm operating contractor is responsible for reviewing and/or preparing technical documents related to the IDF design and construction. The design engineer prepares the construction drawings, technical specifications, and the CQA Plan. The IDF design engineer reports to the IDF PM and supports the IDF project engineer.

1.2.1.2 Field Team

IDF Construction Manager

The IDF CM is an employee or agent of the Tank Farm operating contractor and serves as the point of contact between the IDF construction general contractor and the IDF project team. All construction general contractor correspondence and direction flows through the CM. The CM oversees the daily construction field activities and is the onsite representative for the IDF PM.

CQA Certifying Engineer

The CQA certifying engineer is an employee or agent of the Tank Farm operating contractor who has the overall responsibility of implementing this CQA Plan and directly supervises the CQA monitor, field inspection team, and laboratory technicians. The CQA certifying engineer is responsible for preparation of an implementation plan that addresses how the CQA Plan is to be implemented, and how CQA work is to be performed, tracked, and coordinated, as well as how procedures outlined in this CQA Plan are to be followed. The implementation plan will be submitted to IDF project manager and CM for approval.

Functionally, the CQA certifying engineer submits certified CQA reports to the IDF CM for review and approval by the IDF PM. The CQA certifying engineer is a registered professional engineer in Washington and has the authority to provide a certification letter that the IDF is constructed in accordance with the approved CQA Plan, the approved plans and specifications, and any approved changes. The CQA certifying engineer also has the authority and responsibility to stop work and recommend remedial actions to the IDF PM.

Field Inspector

Field inspectors are employees or agents of the Tank Farm operating contractor and report to the CQA certifying engineer. The field inspector's function is to perform testing and observations, in accordance with this CQA Plan and under the direction of the CQA monitor and CQA certifying engineer.

Soils Laboratory Technicians

Laboratory technicians are employees or agents of the Tank Farm operating contractor and report to the CQA certifying engineer and provide the QA laboratory testing, required by this CQA Plan and as requested by the CQA monitor and CQA certifying engineer.

CQA Surveyor

The CQA surveyor will be an employee or agent of the Tank Farm operating contractor and will be a registered land surveyor in the State of Washington.

CQA Monitor

The CQA monitor is an employee or agent of the Tank Farm operating contractor, reports directly to the CQA certifying engineer, and is a CQA representative, supported by the field inspection team and laboratory technician. The CQA monitor ensures that all CQA tests are performed in accordance with this CQA Plan and accepted procedures.

Construction General Contractor

The IDF construction general contractor is responsible for implementing the approved design by providing the necessary labor, equipment, materials, and all other resources necessary to construct the IDF.

Construction General Contractor Site Supervisor

The site supervisor is an employee or agent of the construction general contractor and is responsible for implementing the IDF construction activities. The site supervisor has overall responsibility for all construction activities related to the IDF, controls day-to-day construction tasks, and is the point of contact for construction general contractor field personnel. The site supervisor ensures the work is progressing in accordance with approved construction contract documents and the approved schedule.

Construction Subcontractors

Construction subcontractors include specialty companies, retained by the IDF construction general contractor, to perform specific work activities at the IDF such as earth moving, geosynthetic lining installation, piping, and building/tank installation. The construction subcontractors report directly to the construction general contractor site supervisor.

Construction General Contractor Quality Control

The construction general contractor provides a construction QC engineer who supports the site supervisor. The primary responsibility of the construction QC engineer is to ensure that the work is performed in accordance with the technical specifications and construction drawings. Specific duties of the construction QC engineer include activities such as preparing construction submittals, field documentation, and interfacing with the CQA certifying engineer.

1.2.2 Project Meetings

The various progress and status meetings that are anticipated to be held throughout the IDF construction are described below. The purpose of the meetings is to discuss work progress, planning, and other issues related to construction. A portion of these meetings can be dedicated to CQA issues, as necessary, to provide an opportunity for the CQA team to express concerns regarding quality, relay test results, and ensure good communication between all organizations involved in the construction of the IDF.

1.2.2.1 Pre-Construction Meeting

A pre-construction meeting will be scheduled prior to beginning construction activities for the IDF. At a minimum, the meeting will be attended by IDF staff including the PM, CM, project engineer, design engineer, as well as the construction general contractor site supervisor, and the CQA certifying engineer. A portion of the meeting will be dedicated to the discussion of QA issues. Suggested CQA topics will include, but not be limited to:

- Reviewing the responsibilities of each organization
- Discussing the authority of agencies and project and field team members to order work stoppages
- Reviewing lines of authority and communication for each organization
- Providing each organization with all relevant CQA documents and supporting information
- Familiarizing each organization with the CQA Plan and its role, relative to the design criteria, plans, and specifications
- Discussing the established procedures or protocol for observations and tests, including sampling strategies
- Discussing the established procedures or protocol for handling construction deficiencies, repairs, and re-testing, including "stop work" conditions
- Reviewing methods for documenting and reporting inspection data
- Reviewing methods for distributing and storing documents and reports
- Reviewing work area security and safety protocol
- Reviewing the proposed project schedule
- Discussing procedures for the location and protection of construction materials and for the prevention of damage of the materials from inclement weather or other adverse events
- Determining action items, assigning actionees, and recording minutes to be transmitted to meeting attendees
- Discussing document control requirements and control of CQA records
- Discussing control and protection of samples

1.2.2.2 Daily Pre-Job Briefing

The construction general contractor will conduct daily pre-job briefings at the work area. The participants will include the construction field personnel, including lower tiered subcontractors and CQA representatives. The primary purpose of these meetings will be to address the day's planned activities. The CQA monitor will discuss CQA activities planned for that day and interface needs with the construction personnel. Suggested CQA topics are:

- Review the work location and activities for the day
- Discuss the construction general contractor's personnel and equipment assignments for the day
- Address scheduling of resources for upcoming work
- Review any new test data
- Discuss any potential construction problems, including unexpected subsurface conditions
- Discuss CQA-planned activities and interface needs

This meeting will be documented and the documentation will be retained on file by the CQA monitor.

1.2.2.3 Construction Progress Meetings

Weekly progress meetings will be held at the site to discuss construction progress. At a minimum, the weekly progress meetings will be attended by the IDF PM, CM, the site supervisor, and the CQA certifying engineer or CQA monitor. The purposes of the meeting are to:

- Review previous activities and accomplishments
- Review claims, change orders, delays, and similar items
- Review planned activities for the upcoming 2-week period
- Finalize resolution of problems from previous meetings
- Discuss potential problems with the work planned for the upcoming 2-week period

Minutes will be recorded and transmitted to meeting attendees and other interested parties.

1.2.2.4 Non-Conformance Meetings

Meetings will be convened as necessary to address non-conformances discovered during inspection. Deficiencies observed during construction by the CQA representatives will be brought to the attention of the IDF CM and CQA certifying engineer and documented using the non-conformance reporting (NCR) procedures outlined in Section 8.1.4. These deficiencies also will be tracked in the CQA representative's field log book until resolution and included in the daily summary report. These documents will include the description of the deficiency and actions taken or to be taken to resolve.

1.2.3 Hold Points

Mandatory hold points will be established for certain key activities. At these points, the IDF construction general contractor will notify the CQA monitor or CQA certifying engineer that the layer or portion of a layer is ready for review. The hold points anticipated for the IDF would be at completion or partial completion of each of the following components:

- Prepared subgrade
- SLDS geomembrane and composite drainage net (CDN)
- SLDS riser pipe
- Soil bentonite admix soil liner
- Secondary GCL
- Secondary geomembrane
- LDS CDN
- LDS piping
- Primary geosynthetic clay liner (GCL)
- Primary geomembrane
- Cushion geotextile
- LCRS piping
- Drain gravel
- Separation geotextile
- Operations layer

On side slopes, a LCRS CDN would substitute for the cushion geotextile, drain gravel, and separation geotextile.

1.3 PERSONNEL QUALIFICATIONS AND TRAINING

This section describes the qualifications and training required for CQA personnel. All documentation relating to qualifications will be maintained with the project CQA records.

1.3.1 CQA Certifying Engineer

The CQA certifying engineer will have landfill construction certification experience. The CQA certifying engineer will, at a minimum, be a registered civil professional engineer in good standing in the State of Washington, possess a bachelor's degree in civil or construction engineering, geotechnical engineering, engineering geology, or a closely related discipline, and have sufficient practical, technical, and managerial experience to successfully direct the CQA activities discussed in this CQA Plan. The CQA certifying engineer's qualifications will be documented by training records and a professional resume showing significant field experience in landfill construction and low permeability soil-bentonite admix liner construction, having directed CQA activities at a minimum of three landfill construction projects or a minimum of 100 acres of combined landfill area certifying experience. The CQA certifying engineer will be familiar with the EPA technical guidance document, *Quality Assurance and Quality Control for Waste Containment Facilities* (EPA 1993). Qualification documentation will be reviewed by the IDF PM and IDF project engineer.

1.3.2 CQA Monitor

At a minimum, the CQA monitor will have a high school diploma and at least five years of construction-related experience, including at least three years of experience conducting CQA monitoring for earthwork construction (including a minimum of three landfill construction projects or a minimum of 50 acres of combined landfill area experience), or a bachelor of science degree from a four-year college or university and at least two years of experience conducting CQA monitoring for earthworks construction (including a minimum of three landfill construction projects). The CQA monitor must be capable of performing work with little or no daily supervision. The CQA monitor will be familiar with the EPA technical guidance document, *Quality Assurance and Quality Control for Waste Containment Facilities* (EPA 1993). Qualifications of the CQA monitor will be documented by training records and a professional resume, reviewed by the IDF PM and CQA certifying engineer.

1.3.3 Field Inspector

At a minimum, the field inspector will have a high school diploma and at least two years of construction-related experience, including at least one year of experience conducting CQA monitoring for earthwork construction, or will have a bachelor of science degree from a four-year college or university and at least six months of experience conducting field inspection for earthworks construction. The field inspector must be capable of routine engineering technician work, under general daily supervision. The field inspector will be familiar with the EPA technical guidance document, *Quality Assurance and Quality Control for Waste Containment Facilities* (EPA 1993). Qualifications of the field inspector will be documented by training records and a professional resume, reviewed by the IDF PM and CQA certifying engineer.

1.3.4 Soils Laboratory Technicians

Laboratory technicians will have at a minimum a high school diploma and at least five years of construction materials laboratory testing related experience, including at least three years of experience performing geotechnical laboratory tests for earthwork construction, including compacted low permeability soil-bentonite admix, or will have a bachelor of science degree from a four-year college or university and at least two years of experience performing geotechnical laboratory tests for earthwork construction, including low permeability soil-bentonite admix. The laboratory technician must be capable of routine laboratory tech work, under general daily supervision. Qualifications of laboratory technicians, including training records and professional resumes, will be reviewed by the IDF PM and CQA certifying engineer.

1.3.5 Geosynthetic Laboratory

The geosynthetic laboratory will be selected by the CQA certifying engineer and will provide the geosynthetic QA conformance testing required by this CQA Plan, as requested by the CQA monitor and/or CQA certifying engineer. The geosynthetics CQA laboratory will be unaffiliated with the materials supplier or manufacturer, or construction general contractor. The geosynthetics CQA laboratory will have at least five years of experience in testing geosynthetics and other relevant liner system components, and will be familiar with American Society for Testing and Materials (ASTM) and other applicable test standards.

1.4 DEFINITIONS RELATING TO CONSTRUCTION QUALITY ASSURANCE

1.4.1 Construction Quality Assurance and Construction Quality Control

Construction Quality Assurance—A planned and systematic pattern of the means and actions designed to provide adequate confidence that items or services meet contractual and regulatory requirements, and will perform satisfactorily in service.

Construction Quality Control (CQC)—Those actions that provide a means to measure and control the characteristics of an item or service to meet contractual and regulatory requirements.

1.4.2 Use of the Terms in This Plan

The definitions used in the context of this CQA Plan are as follows:

- CQA refers to means and actions employed by the CQA representatives to assure conformity of liner system, LCRS, LDS, SLDS, and pipe preparation, production, and installation with this CQA Plan, the technical specifications, and the construction drawings. CQA will be provided by a third party, acting independently from the product manufacturer and construction general contractor.

- CQC refers to those actions taken by manufacturers, suppliers, or construction general contractor, including their designated representatives, to ensure that the materials and the workmanship meet the requirements of the technical specifications and the construction drawings.

1.5 REFERENCES

1.5.1 Applicable Organizations

Organizations whose standards are referenced in the CQA Plan include:

- ASTM—American Society for Testing and Materials
- DOE—Department of Energy
- GRI—Geosynthetic Research Institute
- OSHA—Occupational Safety and Health Administration
- EPA—U.S. Environmental Protection Agency

1.5.2 Applicable Standards

Any reference to standards of any society, institute, association, or governmental agency will pertain to the edition in effect as of the date of this CQA Plan, unless stated otherwise.

Specific test standards for tests cited in the CQA Plan are provided in the technical specifications. These standards may be modified due to technological advances since compilation of the technical specifications. All such modifications are to be approved in accordance with change order procedures described in Section 8.1.5.

1.6 CONSTRUCTION ACTIVITIES AND SUBMITTAL REQUIREMENTS

1.6.1 Construction Activities

This section describes the construction activities and submittal requirements that will be performed by the construction general contractor during the IDF construction. This CQA Plan only addresses selected activities of the Phase I construction.

In general, construction activities will consist of preparing the subgrade, installing the liner system, the leak detection systems (LDS and SLDS), the leachate collection and removal system (LCRS), and operations layer and necessary equipment to complete the landfill for waste acceptance. Construction will consist of these activities:

- Mobilizing construction equipment and personnel
- Vendor data submittals
- Installing sediment and erosion control
- Preparing soil bentonite material
- Excavation, embankment, fine grading of landfill subgrade, and sump construction
- Constructing the secondary leak detection system (SLDS) sump
- Constructing the soil bentonite admix liner (SBL)
- Dust control activities during construction
- Placing the geosynthetics for the secondary liner
- Constructing the leak detection system (LDS)
- Placing the geosynthetics for the primary liner
- Constructing the leachate collection and removal system
- Constructing the operations layer
- Site restoration
- Demobilization

Prior to the start of construction activities, the CQA representatives will review and become familiar with all construction drawings, technical specifications, the CQA Plan, and RCRA permit. The CQA certifying engineer also will be familiar with the most recent construction schedule, so that adequate resources (i.e., laboratory, field testing equipment, staff, and CQA forms), including contingencies (e.g., backup equipment, alternate laboratory, and alternate CQA staff) for CQA activities, will be commensurate with the anticipated construction productivity and work schedule.

1.6.2 Submittal Requirements

The construction general contractor will provide the submittals required (listed in Table 1-1 in this section) to the IDF PM. Submittals will be provided far enough in advance of scheduled installation dates to allow time for reviews, possible revisions and resubmittals, placing orders, and securing delivery. The construction general contractor will identify, track, and disposition all required vendor data. The IDF PM will respond to each required submittal as stated in the technical specifications.

The submittals presented in Table 1-1 will be required as a minimum. A master submittal list will be provided as part of the contract documents.

1.6.3 Receipt Inspection Procedures

Inventory of manufactured materials used in lining system construction is detailed in Sections 3.1.4 (GCL), 4.1.4 (geomembrane), 5.1.4 (geotextiles), 6.1.4 (CDN) and 7.1.4 (polyethylene piping). The purpose of this section is to provide a general summary of the minimum requirements and procedures for receiving and controlling purchased materials, equipment, or services as required by the contract documents.

Procurement, receipt, and inspection of construction materials and equipment are the responsibilities of the construction general contractor, with verification by the CQA certifying engineer and IDF CM. Procedures specific to the IDF Phase I construction project will be prepared as part of the construction quality control (QC) plan, to be submitted by the construction general contractor.

Procedures to control receipt inspection will include the following, at a minimum:

- The contract documents will provide a master submittal list that identifies the materials, equipment, or services requiring receipt inspection. Upon delivery to the project site, the general construction contractor will attach secure and visible "Quality Hold for Inspection" tags to each item.
- All items, materials, and equipment that have been tagged will be stored in segregated areas, as identified in the contract documents. Items will be restricted from further use until all construction general contractor and CQA certifying engineer inspections are completed.
- Upon inspection if items, materials, or equipment held for inspection, the "Quality Hold for Inspection" tag will be removed and replaced with one of the following, as appropriate:
  a) Acceptance tag
  b) Non-conformance (red) tag
  c) Conditional use tag
- The construction general contractor may utilize only those items tagged as "Accepted" or "Conditional Use."
- Red tagged materials will not be used in construction and will be moved to a segregated area or removed from the site.
- Conditional use tagged materials are restricted to use for specific conditions identified on the tag.
- Documentation of receipt inspection will be completed, maintained, and stored in a single location, in a secure and protected environment for the full performance period of the construction contract.

TABLE 1-1
Required Submittals

Submittal	Description	Requirement
Source Quality Control for Imported Materials (structural fill, drain gravel and crushed surfacing)	Gradation tests performed in accordance with ASTM D422 by a qualified independent test laboratory for imported materials on samples taken at place of production prior to shipment. Samples will be taken for gradation testing from every 2,000 tons of prepared materials, in accordance with ASTM D75.	Submitted by the construction general contractor and approved by the IDF PM prior to the shipment of material to the project site.
Geomembrane Installation Plan	Proposed layout drawings for each layer of geomembrane material. Geomembrane layout will show panel configuration, general dimensions, and seam locations.	Submitted by the construction general contractor and approved by the IDF PM prior to the installation of the respective geomembrane liner.
Subgrade surface acceptance	Certification in writing that the surface on which the geomembrane will be installed is acceptable to the installer. A certificate of acceptance will be provided by the construction general contractor to the CQA representative, who will then verify to the CQA certifying engineer that the deployment surface has been accepted immediately prior to commencement of geomembrane installation in the area under consideration.	Certificate signed by the installer and construction general contractor prior to installation of geomembrane over the subgrade.
GCL quality control certifications, test data and properties guarantee	Provide manufacturer's quality control (QC) test data for GCL material to be installed, including: Bentonite – suppliers' name and location, brand name, lot number, dated quality control information from supplier, manufacturer's test data verifying that bentonite meets manufacturer's specifications. GCL – written guarantee that GCL conforms to the technical specification requirements and test certificates for each production lot or 50,000 square feet of GCL material including roll numbers, test methods, and test results verifying compliance with the technical specification requirements for GCL.	Submitted by the construction general contractor prior to installation of the GCL material and approved by the IDF PM.

TABLE 1-1
Required Submittals

Submittal	Description	Requirement
Geomembrane quality control certifications, test data and properties guarantee	QC Testing shall be performed by manufacturer to demonstrate the geomembrane conforms to technical specification requirements. Prior to delivery of any geomembrane material, the manufacturer shall submit all required information listed in the technical specifications (Section 02661). <u>QC Certification:</u> Prior to shipment, the geomembrane manufacturer shall provide a quality control certificate for each roll of geomembrane. The quality control certificate shall be signed by a responsible party employed by the geomembrane manufacturer, such as the production manager. The quality control certificate shall include: 1. Roll numbers and identification, resin lot, and batch numbers. 2. Sampling procedures and results of quality control tests. As a minimum, results shall be given for thickness, asperity, tensile strength, and tear resistance in accordance with methods indicated in the technical specifications. Tests shall be conducted on each production lot of geomembrane or every 50,000 square feet, whichever results in the greater number of tests.	Submitted by the construction general contractor prior to installation of the geomembrane material and approved by the IDF PM.
Geotextile material certifications and test data	Provide manufacturer's QC test data for geotextile material to be installed, including: Geotextile – written guarantee that geotextile conforms to specification requirements, certification that manufacturer continuously inspected geotextile for presence of needles and found it to be needle-free, and test certificates for geotextile material including roll numbers, test methods, and test results verifying compliance with the technical specifications physical properties for geotextile. Frequency of manufacturer's QC testing shall be at the standard rate stated in the manufacturer's QC plan for each required property in the technical specifications.	Submitted by the construction general contractor prior to installation of the geotextile material and approved by the IDF PM.
Composite drainage net material certifications and test data	Provide manufacturer's QC test data for composite drainage net material to be installed, including: Composite drainage net – manufacturer's specification measured using appropriate test methods, written guarantee that composite drainage net conforms to specification requirements, manufacturer's QC test data for the geotextile component as specified above for geotextile, and test certificates for composite drainage net material and geonet component including roll numbers, test methods, and test results verifying compliance with the technical specification requirements for composite drainage net and geonet. Frequency of manufacturer's QC testing shall be at the standard rate stated in the manufacturer's QC plan for each required property in the technical specifications	Submitted by the construction general contractor prior to installation of the composite drainage net material and approved by the IDF PM.

TABLE 1-1
Required Submittals

Submittal	Description	Requirement
Interface Shear Strength test data	Provide data prior to material shipment for the interface friction angle between the textured geomembrane and other materials (including CDN, GCL, and Admix Liner) directly in contact with the geomembrane as specified in Section 02661; and between the CDN and the operations layer as specified in Section 02373 of the technical specifications. Friction angle shall be determined by direct shear testing under fully saturated conditions (ASTM D5321 or D6243 for GCL interface) at low nominal normal loads of both 100, 250, and 500 pounds per square foot (psf), and high nominal normal loads of 2,000, 8,000, and 15,000 psf, except for the CDN/Operations Layer interface which shall be reported at low normal load only. Report results for both peak and large displacement (minimum 2 inches) strength. Perform two interface shear strength tests on each interface under each set of normal loads.	Submitted by the construction general contractor prior to geosynthetic material shipment and reviewed and approved by the IDF PM for conformance with project strength requirements. Allow IDF PM a minimum 20 working days for this evaluation upon receipt of data.
Admix Liner Preparation and Placement Plan	Provide a detailed plan for preparation of the admix material, including a description of the equipment and procedures to be used, personnel qualifications, equipment calibration certificates and methods for monitoring bentonite additions and moisture conditioning. Also provide an admix liner placement plan to specify lift thickness control and to allow for required testing, described in the CQA Plan and technical specifications on the admix liner during placement operations.	Submitted by the construction general contractor prior to start of admix production for approval by IDF PM.
Bentonite QC certificates and test data	Provide bentonite supplier's descriptive data, specification sheets, literature, and other data as necessary to fully demonstrate that the bentonite proposed for use in the admix complies with the requirements of the technical specifications. The manufacturer shall certify that the bentonite furnished complies with these Specifications. A certificate shall be submitted to the CQA Engineer for each railcar or every three truckloads of bentonite delivered.	Submitted by the construction general contractor prior to start of admix production for approval by IDF PM.
Polyethylene Pipe and Fittings	Provide manufacturer's QC test data for piping and fittings that will be installed on the landfill floors and slopes.	Submitted by the construction general contractor prior to installation of the pipe for approval by the IDF PM.

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SECTION II–SOILS CONSTRUCTION QUALITY ASSURANCE

This section discusses the CQA requirements for soil layers including fill placement, subgrade preparation, admix liner, drain gravel, and operations layer.

2.1 FILL PLACEMENT AND SUBGRADE PREPARATION

This section of the CQA Plan addresses the soils components necessary to provide a prepared subgrade for the liner systems and specifies the soils CQA program to be implemented with regard to materials selection and evaluation, laboratory test requirements, field-test requirements, and corrective action requirements.

2.1.1 Fill Placement and Compaction

The technical specifications will be followed for the stockpiling, placement, and compaction of earthfill and structural fill. The CQA monitor will monitor the fill placement and compaction to verify and document the following:

- The soil being placed meets the technical specifications requirements for earthfill and structural fill as determined by the test methods and frequencies specified within this CQA Plan and the source quality control submittals.
- The placement surface has been prepared as specified in the technical specifications.
- The compacted lift thickness is in accordance with the requirements of the technical specifications.
- The dry unit weight of the earthfill and structural fill meets specifications as determined by the test methods and frequencies described in Table 2-1 for earthfill and Table 2-2 for structural fill.
- Material placed in permanent stockpiles meets the appropriate specifications for earthfill or structural fill.

2.1.2 Construction Quality Assurance Evaluation

The frequency of soils testing for CQA purposes will conform to the minimum frequencies presented in Table 2-1 for earthfill and Table 2-2 for structural fill. Material properties will be determined from samples collected either immediately after placement or from stockpiles.

Nuclear density meter test methods will be used for the field testing of the in situ dry unit weight of the in-place, compacted fill. Any settlement or other defects in the fill will be backfilled and compacted in accordance with the technical specifications.

Standard count calibrations will be conducted to monitor the aging of the nuclear density gauge sources in accordance with ASTM standards. Sand cone or drive sleeve tests will be conducted periodically to verify densities using the nuclear density gauge. Oven moisture content tests will be conducted and compared to field moisture content results to determine a field correction factor for moisture. Sand cone or drive sleeve tests and in situ moisture content tests will be performed at the frequencies specified in Tables 2-1 and 2-2.

If an in-place density test result fails to meet specifications, a confirmatory test will be performed immediately adjacent to the failed test. If the confirmatory test meets or exceeds specifications, a second confirmatory test will be performed at a second location immediately next to the failed test. If the second confirmatory test also meets or exceeds specifications, the area will be declared as meeting project specifications and the confirmatory tests will be reported. In the event that either confirmatory test fails to meet specifications, a CQA representative will determine the extent and nature of the defect by observations and/or additional testing, as necessary, to identify the limits of the area that does not meet project specifications.

If a defective area is discovered in the fill, a CQA representative will determine the extent and nature of the defect. If the defect is indicated by an unsatisfactory test result, the CQA representative will determine the extent of the defective area by additional tests, observations, a review of records, or other means that the CQA representative deems appropriate. If the defect is related to adverse site conditions, such as excessively wet soils or surface desiccation, the CQA representative will define the limits and nature of the defect by testing or observation. After the extent and nature of a defect is determined and remedied by the construction general contractor, the CQA representative will verify that the deficiency has been corrected by re-testing repaired areas before any additional work is performed by the construction general contractor in the area of the deficiency. All confirmatory tests, failing tests, and re-tests will be recorded in the CQA representative's field book or compaction testing form. The approximate location and elevation of each test will be recorded.

The CQA representative will document fill placement and compaction as determined by the test methods and frequency prescribed by this CQA Plan and will report any non-conformance in accordance with the non-conformance reporting procedures outlined in Section 8.1.4.

2.2 PREPARED SUBGRADE

The CQA representative will verify and document that the prepared subgrade is constructed to the elevations and grades shown in the construction drawings, with subgrade meeting the requirements of the technical specifications as determined by the test methods and frequencies specified within this CQA Plan.

Upon completion of the excavation of the landfill, the CQA monitor will perform the following tasks:

- Inspect the subgrade on the side slopes and base of the landfill and note areas of weak or excessively weathered subgrade materials
- Observe completion of excavation and subgrade compaction prior to foundation, fill, or liner placement
- Observe the proof rolling of the base of the landfill and note areas that exhibit excessive rutting, heaving, or softening

- Observe that the surface of the subgrade is free of debris, wet and soft areas, standing water, vegetation, mud, ice, or frozen material
- Observe any excavation and backfilling operations associated with unsuitable material found in the prepared subgrade
- Verify that a survey has been conducted to further verify that the subgrade grades and elevations conform to the construction drawings
- Verify that the prepared subgrade material meets the requirements of the technical specifications as determined by the CQA testing methods and frequency in Table 2-3
- Verify that sampling points in the prepared subgrade are plugged or backfilled so that the prepared subgrade meets the technical specifications
- Document the location and volume of any unsuitable material removed from the prepared subgrade and report any non-conformance with the technical specifications in accordance with the non-conformance reporting procedures in Section 8.1.4

2.2.1 Layer Completion Certification

The construction general contractor will be required to notify the CQA representative when an area of prepared subgrade is complete prior to constructing the overlying layer. The construction general contractor can proceed with the overlying layer upon acceptance of the area of prepared subgrade by the CQA representative. The CQA certifying engineer will provide a certificate of layer completion to the construction general contractor and the IDF project engineer, certifying that the area is complete.

2.3 SOIL BENTONITE ADMIX LINER AND TEST PADS

The soil bentonite admix liner (SBL) is composed of a mixture of base soil and bentonite material. Two SBL test pads will include both a horizontal and a sloped test pad. The horizontal test pad will be constructed by using the same compaction methods as that used for the production SBL, to ensure the SBL is constructed to meet the minimum hydraulic conductivity requirements. The sloped test pad will be constructed on a sloping surface to verify that compaction methods (determined during the horizontal test pad) will be adequate for the side slopes of the landfill. If necessary, the technical specifications and/or CQA Plan may be modified, based on the results of the test pads.

2.3.1 Test Pads

Test pads will be constructed by the construction general contractor to determine acceptable placement and compaction methods to produce a low permeable SBL on a horizontal surface and on a 3H:1V side slope that satisfies the performance requirements of the technical specifications.

In addition, the mixing of the base soil and bentonite admixture using the pugmill will be tested to ensure adequate control of the ratio of admixture components as well as the homogeneity of the completed SBL mixture.

2.3.1.1 Construction Quality Assurance Evaluation

During test pad construction, the CQA representative will continuously observe and document the construction of the test pad. These guidelines will be followed to ensure that the test pad accurately represents the performance of the full-scale facility:

- Construction of the test pad will use the same soil material, design specifications, equipment, and procedures as proposed for the full-scale facility.
- The test pad length, width, and depth will be as required by the technical specifications and for the in-situ hydraulic conductivity test spacing.
- The number of lifts used to construct the test pad will be as required by the technical specifications.

The test pad will be constructed to allow determination of the relationship among density, moisture content, and method of compaction. Field variables can affect this relationship and must be carefully measured and controlled, both in the test pad and during construction of the full-scale liner. At a minimum, the following will be observed and documented:

- Track weight of base soil and bentonite during mixing operations
- Mixing operation homogeneity
- Test pad configuration and dimensions
- Compaction equipment type, configuration, and weight
- Number of passes and speed of the compaction equipment
- Uncompacted and compacted lift thickness
- Weather conditions, including ambient temperature, humidity, wind speed and direction, and precipitation

The CQA representative will provide the necessary surveying and/or reference grid points for adequately and expeditiously determining the elevation and dimensions of the test pad, including each lift.

The CQA representative will be responsible for all testing, surveying, and documentation necessary to verify that the test pad performs in accordance with the technical specifications, and that the methods, equipment, and materials used can achieve the same results or better during full-scale construction.

Testing methods and frequencies will be as indicated in Table 2-4. Additional tests may be conducted at the direction of the CQA certifying engineer. All tests will be conducted in accordance with the methods and procedures specified in Table 2-4. Tests are separately identified in Table 2-4 which are intended to provide the following:

- Information Only, for use in evaluating overall methods , materials, or equipment
- Pass/Fail, that have criteria established in the technical specifications which must be met
- Calibration and Check, for use in calibrating instruments

The CQA certifying engineer will compare the results of the test pad constructed on the level surface with the results of the test pad on the side slopes. The CQA certifying engineer will recommend changes to compaction methods, if necessary, to the IDF project engineer. The CQA certifying engineer will prepare an interim report which summarizes the construction and testing of the test pads.

It is important to note that an acceptable zone has been established in the technical specifications for the allowable moisture content and density ranges that are applicable for the SBL admix to meet minimum permeability requirements. This zone may be adjusted as a result of the test pad data obtained during construction to reflect specific conditions observed based on the construction general contractor's proposed blending, placement, and compaction methods. With the range of placement moisture content and density allowed with this approach, minimum compaction effort (i.e., the number of passes a piece of compaction equipment needs to bring the admix into the allowable moisture/density zone) will vary based on material conditions and placement location. Minimum compaction effort recommendations will be developed by the CQA certifying engineer for application to both bottom slope and side-slope admix construction based on test pad results. However, these minimums should be considered as guidelines only and may need to be adjusted based on changes to admix properties (primarily moisture content), site conditions, and compaction location as needed to bring the admix into the required acceptable zone for compaction.

2.3.2 Soil Bentonite Admix Liner

The CQA team will verify and document that the SBL is placed to the elevations, grades, and thicknesses shown in the construction drawings, with bentonite-amended material meeting the requirements of the technical specifications as determined by the test methods and frequencies specified within this CQA Plan.

2.3.2.1 Construction Quality Assurance Evaluation

CQA testing will be performed during processing and placement of the SBL. The CQA team will conduct the processing and placement tests for the SBL as specified in Table 2-5. The maximum allowable percentage of failing tests is specified in Table 2-6.

Processing

The construction general contractor shall process and condition admix material using a central type pugmill plant as described in the technical specifications. Prior to amending the base soil with bentonite, a CQA representative will verify and document the following:

- Equipment and methods are the same or equivalent as determined from the test pad studies.
- All submittals have been reviewed and approved.
- The base soil source area (either onsite excavation or borrow area) has been approved by the design engineer, IDF PM, or IDF project engineer.
- The mixing equipment is suitable for amending base soils with bentonite.
- The base soil does not contain rocks with dimensions in excess of those required by the technical specifications.

During processing, the CQA representative will verify and document the following:

- The bentonite is in conformance with the technical specifications.
- Close observation of the base soil excavation and processing is performed by the field inspector.

- The processed SBL material meets the requirements of the technical specifications as determined by the CQA testing methods and frequency in Table 2-5.
- The moisture content and consistency of base soil allow bentonite to be mixed uniformly.
- Bentonite amendments are mixed uniformly with the base soil.
- The processed SBL material is stored, protected, and allowed to cure in accordance with the conditions and minimum requirements of the technical specifications.
- Calibration of the pugmill operation feed rate controls for bentonite, base soil and water.
- The bentonite is mixed at the required application rate, established by the technical specifications as determined by the CQA testing methods and frequency in Table 2-5.

The CQA representative will document the properties of the processed soil bentonite material, as determined by the test methods and frequency prescribed by this CQA Plan, and will report any non-conformance with the technical specifications, following procedures outlined in Section 8.1.4.

The CQA representative will observe processing activities including base soil excavation, bentonite blending, and moisture conditioning.

The CQA representative will monitor the excavation of base soil from the approved borrow source or onsite excavations. Deleterious base soil or base soil not meeting the technical specifications will be identified and reported to the CQA certifying engineer and not allowed in the processing area.

CQA tests will be performed on the raw bentonite used in the SBL to verify conformance to the technical specifications. The CQA representative will collect samples of raw bentonite delivered to the site for testing. The CQA laboratory technician will conduct free swell, and grain size tests of the bentonite in accordance with Table 2-5. If the test results of a sample fail to meet specifications, a confirmatory test will be performed immediately subsequent to the failed test. If the confirmatory test meets or exceeds specifications, a second confirmatory test will be performed. If the second confirmatory test also meets or exceeds specifications, the bentonite will be declared as meeting project specifications and the confirmatory tests will be reported. In the event that either confirmatory test fails to meet specifications, the bentonite will be rejected and removed from the site.

The CQA representative will observe mixing and test the bentonite-amended soil, prior to placing it in the landfill.

Placement

Prior to the placement of the SBL, the CQA representative will verify and document the following:

- The test pads have been constructed with the approved liner material and production scale equipment to confirm placement and compaction procedures produce the required low-permeability admix for both on a horizontal surface and on a 3H:1V side slope.
- All or an approved portion of the prepared subgrade meets specifications as determined by the test requirements of this CQA Plan and the CQA certifying engineer has issued the completion certificate.

- The SBL material is free of roots, stumps, vegetation, or any other type of deleterious material that may impact the performance of the placed SBL.
- The SBL material does not contain stones with dimensions in excess of those required by the technical specifications.
- The SBL material meets or exceeds the requirements of the technical specifications as determined by the CQA testing methods and frequency in Table 2-5.
- The moisture content of the SBL material is uniform.

During placement and compaction of the SBL, the CQA Team will verify and document the following:

- Close observation of the placement and compaction of SBL material with earthmoving equipment is performed by the field inspectors. Inspectors to verify that means and methods are the same as those approved in the test pad process.
- The SBL material meets the requirements of the technical specifications as determined by the CQA testing methods and frequency in Table 2-5 and is within the maximum allowable failure rates in Table 2-6.
- The SBL is placed in accordance with the conditions and minimum requirements of the technical specifications.
- Each lift is compacted to the required thickness and minimum dry unit weight within the range of moisture contents established by the technical specifications as determined by the CQA testing methods and frequency in Table 2-5.
- Shelby tube samples are collected for laboratory permeability testing at the frequency specified in Table 2-5.
- Penetrations in the SBL at testing and sampling locations are repaired in accordance with the technical specifications.
- The SBL is maintained until it is covered by the geomembrane liner in accordance with the technical specifications.
- In areas of inaccessibility by the compactor, in areas of nonstandard SBL placement, and/or in areas of different compaction methods, more frequent testing will be performed due to thinner lift thicknesses to achieve equivalent compactive effort. Each lift, no matter how thin, will be tested for density and moisture in accordance with Table 2-5.

The CQA representative will document the properties of the SBL as determined by the test methods and frequency prescribed by this CQA Plan and will report any non-conformance in accordance with the non-conformance reporting, as outlined in Section 8.1.4.

The CQA representatives will collect samples immediately after a loose lift of SBL materials has been placed for property tests, prior to compaction. Once compacted, nuclear density gauge test methods will be used for testing the in situ compacted dry unit weight and moisture content of the SBL. Standard count calibration and moisture content tests will be used to calibrate the reading of the nuclear density gauge. Standard count calibration and in situ moisture content tests, using the oven dry method, will be performed at the frequencies specified in Table 2-5. The results of the oven dry moisture content tests will be compared with the field moisture content results to determine a field moisture correction factor. The CQA representative will adjust the field moisture correction factor as test data is collected (i.e., moving average). The CQA representative will collect Shelby tube samples of the SBL for laboratory permeability tests as specified in Table 2-5.

If in-place density test results fail to meet specifications, a confirmatory test will be performed immediately adjacent to (within 3 ft of) the failed test. If the confirmatory test meets or exceeds specifications, a second confirmatory test will be performed at a second location immediately next to (within 3 ft of) the failed test. If the second confirmatory test also meets or exceeds specifications, the area will be declared as meeting project specifications and the confirmatory tests will be reported. In the event that either confirmatory test fails to meet specifications, additional testing will be performed to identify the limits of the area that does not meet project specifications. All confirmatory tests, failing tests, and re-tests will be recorded in the CQA representative's field book or compaction testing form. The approximate location and elevation of each test will be recorded.

Rapid laboratory permeability tests, such as the constant volume tests, will be used when possible to determine permeability. Once the sample has achieved the specified permeability, the test result will be reported immediately to the CQA certifying engineer. The number of failing tests will be less than the maximum percentage of failing tests specified in Table 2-6. The maximum percentage of failing tests are anticipated to cover laboratory or field recording mistakes, math errors, or other unknown circumstances that are not discovered until after the layer is covered with the succeeding layer(s). Otherwise, all failed tests will be corrected in the field as they are observed.

If a defective area is discovered in the SBL other than a failed in-place density test, the CQA representative will determine the extent and nature of the defect. If the defect is indicated by an unsatisfactory test result, the CQA representative will determine the extent of the defective area by additional tests, observations, a review of records, or other means that the CQA representative deems appropriate. If the defect is related to adverse site conditions, such as excessively wet soils or surface desiccation, the CQA representative will define the limits and nature of the defect by testing or observation. After the extent and nature of a defect is determined and remedied by the construction general contractor, the CQA representative will verify that the deficiency has been corrected by re-testing repaired areas before any additional work is performed by the construction general contractor in the area of the deficiency.

The testing frequency during the SBL construction may be increased or modified at the discretion of the CQA certifying engineer, when visual observations of construction performance indicate potential problems or when field experience with the proposed SBL material have been obtained.

During construction, the frequency of testing may be increased by the CQA representative during adverse weather conditions, if equipment breaks down, at the start and finish of grading, if the material fails to meet the requirements of the technical specifications, or if the extent of the work area is reduced.

The construction general contractor will repair all penetrations in the SBL resulting from sampling and other CQA activities, in accordance with the technical specifications. These perforations will be identified to the construction general contractor by the CQA representative. All repairs will be inspected by the CQA representative.

The construction general contractor will be required to use all means necessary to protect all prior work as well as all materials and completed work of other sections. In the event of damage, the construction general contractor will be required to immediately make all repairs and replacements necessary. The CQA representative will verify and document that all damages are repaired.

2.3.2.2 Layer Completion Certification

The construction general contractor will be required to notify the CQA representative when an area of SBL is complete, prior to constructing the overlying layer. The construction general contractor may begin placement of the overlying layer after acceptance of the SBL by the CQA certifying engineer. The CQA certifying engineer will provide a certificate of layer completion to the construction general contractor and the IDF project engineer, certifying that the area is complete.

The CQA certifying engineer will ensure all CQA tests are complete and that all defective areas have been repaired and re-tested in accordance with this CQA Plan and the technical specifications. The certificate of layer completion will indicate that the SBL meets the low permeability requirement, based on laboratory tests and the thickness of the SBL meeting the minimum requirement specified in the technical specifications.

2.4 DRAIN GRAVEL

2.4.1 Conformance Evaluation

No CQA conformance material testing is planned for the drain gravel. Construction general contractor is required to submit gradation test results demonstrating conformance with required material properties as part of source quality control, in accordance with the technical specifications.

2.4.2 Placement and Compaction

The CQA representative will verify and document that the drain gravel is constructed to the elevations, grades, and thicknesses shown in the construction drawings, with material meeting the requirements of the technical specifications as determined by the test methods and frequencies specified within this CQA Plan.

Prior to the placement of the drain gravel, the CQA representative will verify and document that:

- The underlying geosynthetic layers are free of holes, tears, excessive wrinkles, or foreign objects.
- All work on underlying layers is complete and accepted by the CQA certifying engineer.

During placement and compaction of the drain gravel, the CQA representative will verify and document the following:

- Drain gravel material satisfies the requirements of the technical specifications as determined by the source quality control submittals.
- Drain gravel material is non-angular and free of material that could damage the underlying liner materials.
- Drain gravel material is spread during cooler portions of the day, unless otherwise approved by the CQA certifying engineer.
- Spreading and hauling equipment and operations are in compliance with material thickness and operations requirements, given in the technical specifications.
- If excessive wrinkles begin to develop in the underlying geosynthetics during gravel or sand placement or spreading, the wrinkles are worked out prior to continued placement operations.
- The drain gravel is placed in a manner that will not damage underlying geosynthetics, will minimize slippage of geosynthetic layers, and will not provide excess tensile stress on the geosynthetics, in accordance with the technical specifications.
- Close observation of the placement and compaction of drain gravel with earth moving equipment is performed.

2.4.3 Construction Quality Assurance Evaluation

No density tests will be conducted on the drain gravel. If the CQA representative suspects damage to pipes or underlying geosynthetic, the construction general contractor will be required to expose the potentially damaged materials and repair any observed damage.

2.4.4 Layer Completion Certification

The construction general contractor will be required to notify the CQA representative when an area of the LCRS or LDS drain gravel is complete, prior to constructing the overlying layer. The construction general contractor may begin placing the overlying layer when the drain gravel is accepted by the CQA certifying engineer. The CQA certifying engineer will provide a certificate of layer completion to the construction general contractor and the IDF project engineer, certifying that the area is complete.

2.5 OPERATIONS LAYER

The CQA representative will verify and document that the operations layer, including the operations layer material placed in the SLDS sump area, is constructed to the elevations, grades, and thicknesses shown in the construction drawings, with material meeting the requirements of the technical specifications as determined by the test methods and frequencies specified within this CQA Plan.

Prior to the placement of the operations layer, the CQA representative will verify and document the following:

- The underlying geosynthetic layer is free of holes, tears, excessive wrinkles, or foreign objects.
- All work on underlying layers is complete and accepted by the CQA certifying engineer.

During placement of the operations layer, the CQA representative will verify and document that:

- The soil is suitable and satisfies the requirements of the technical specifications as determined by the test methods and frequencies prescribed in Table 2-7.
- The operations soil is placed in accordance with the technical specifications and construction drawings.
- The lift thicknesses and total thickness of the operations layer agree with the requirements of the construction drawings.
- If excessive wrinkles begin to develop in the underlying geosynthetics during material placement or spreading, the wrinkles are worked out prior to continued placement operations.
- The operations layer is placed in a manner that will not damage underlying geosynthetics, will minimize slippage of geosynthetic layers, and will not provide excess tensile stress on the geosynthetics, in accordance with the technical specifications.
- Spreading and hauling equipment and operations are in compliance with material thickness and operations requirements given in the technical specifications.
- The operations layer is placed on the side slopes to the limits shown in the construction drawings.
- No operations layer material is placed or compacted during periods of unfavorable weather conditions, such as after heavy rains or snow, in accordance with requirements given in the technical specifications.

2.5.1 Conformance Evaluation

The test methods and frequencies for CQA conformance testing for the operations layer are specified in Table 2-7.

If damage to underlying geosynthetics is suspected, the CQA representative will require that the overlying operations layer material be removed to expose the geosynthetics.

The construction general contractor will be required to use all means necessary to protect all prior work, as well as all materials and completed work of other sections. In the event of damage, the construction general contractor will be required to immediately make all repairs and replacements necessary. The CQA representative will verify and document that all damages are repaired.

2.5.2 Layer Completion Certification

The construction general contractor will be required to notify the CQA representative when an area of the operations layer is complete. The CQA certifying engineer will provide a certificate of layer completion to the construction general contractor and the IDF project engineer, certifying that the area is complete.

2.6 SOIL SURVEYING

A survey will be performed by or under the direction of a professional land surveyor registered in the State of Washington. The surveyor will independently survey the elevations and grades of the soil layers including, but not limited to:

- Top of prepared subgrade
- Top of SBL
- Top of LCRS drain gravel
- Top of operations layer

Surveys will be performed on the base and side slopes of the landfill, to confirm that the grades and elevations in the field agree with those shown in the construction drawings and with the minimum acceptable tolerances required in the technical specifications. The results of the survey, conducted by the surveyor, will be compiled in a report signed by the surveyor and the CQA certifying engineer.

The surveyor will be required to survey each soil layer of the liner system for the IDF landfill, in accordance with the requirements of this CQA Plan. A record drawing or tabular listing of surveyed points will be submitted to the CQA certifying engineer by the surveyor before the placement of the next liner system layer. The surveys will be conducted at a 50-ft grid across the entire area of the survey. The survey will include, but not be limited to, the following features of the landfill:

- Toe of slope
- Crest of slope
- Grade breaks
- Anchor trench
- SLDS, LDS and LCRS sumps

TABLE 2-1
Minimum Frequency of Testing for CQA Evaluation of Earthfill

Test	Frequency	Standard Test Method
Material Properties		
Standard proctor or maximum index density for free-draining soil	1 per 20,000 yd^3 (minimum 1 per source or soil type)	ASTM D698 or ASTM D4253
Placement		
In-place wet unit weight	1 per 5,000 ft^2 per lift	ASTM D2922, D1556
In-place moisture content	1 per 5,000 ft^2 per lift	ASTM D3017, D2216
Standard count calibration	1 per day of fill placement	ASTM D3017/D2922
Oven moisture contents (in situ moisture content)	1 per day of fill placement	ASTM D2216

TABLE 2-2
Minimum Frequency of Testing for CQA Evaluation of Structural Fill

Test	Frequency	Standard Test Method
Material Properties		
Standard proctor or maximum index density for free-draining soil	1 per 2,000 tons (minimum 1 per source or soil type)	ASTM 698 or ASTM 4253
Placement		
In place moisture content	1 per 2,500 ft^2 per lift	ASTM D3017, D2216
In place dry unit weight	1 per 2,500 ft^2 per lift	ASTM D2922, D1556
Standard count calibration	1 per day of fill placement	ASTM D3017/D2922
Oven moisture contents (in situ moisture content)	1 per day of fill placement	ASTM D2216

TABLE 2-3
Minimum Frequency of Testing for CQA Evaluation of Prepared Subgrade

Test	Frequency	Standard Test Method
Material Properties[a]		
Standard proctor or maximum index density for free-draining soil	1 per 250,000 ft^2 (minimum 1 per source or soil type)	ASTM 698 or ASTM 4253
In Place[b]		
In-place wet unit weight	4 per acre (approx. 1 per 10,000 ft^2)	ASTM D2922, D1556
In-place moisture content	4 per acre (approx. 1 per 10,000 ft^2)	ASTM D3017, D2216
Standard count calibration	1 per day when in place tests are performed	ASTM D3017/D2922
Concrete block calibration	1 per day when in place tests are performed	ASTM D3017/D2922
Over moisture content (in situ moisture content)	1 per day when in place tests are performed	ASTM D2216

a. Prior to subgrade excavation.
b. After reaching subgrade elevation.

TABLE 2-4
Test Pad Testing Methods and Minimum Frequency

Test	Frequency	Standard Test Method
Material Property		
Natural moisture content [a]	4 per each Base Soil type per test pad	ASTM D2216
Particle size distribution [b]	4 per each Base Soil type per test pad	ASTM D422
Standard proctor [a]	4 per each Base Soil type per test pad	ASTM D698
Bentonite dry fineness [b]	1 per test pad	Technical specification
Bentonite high swelling [b]	1 per test pad	Technical specification
Processing [b]		
Bentonite/Base Soil application rate	1 per working day of admix processing during test pad construction	Measure weight of base soil and bentonite entering pugmill during a given period of time
Maximum clod size	Periodic monitoring	Observation
Curing	1 per 12 hours	Observation
Pre Compaction [a]		
Lift thickness	1 per lift	Field measurement
Percent fines	1 per lift	ASTM D1140
Percent gravel	1 per lift	ASTM D422
Atterberg limits	1 per lift	ASTM D4318
Placement	Periodic monitoring	Observation
Post Compaction		
Lift thickness [b]	4 per lift	Field measurement
In-place moisture content [b]	4 per lift	ASTM D3017
In-place dry unit weight [b]	4 per lift	ASTM D2922
Shelby tube samples [b] (laboratory permeability)	1 per lift	ASTM D1587/ASTM D5084[c,d]
Number of passes [a]	Monitor each lift	Observation
Boutwell permeameter test [b]	5 for the horizontal test pad only	ASTM D6391, first stage only
Calibration and Check [e]		
Standard count calibration	1 per day of fill placement	ASTM D3017/D2922
Oven moisture contents (in situ moisture content)	1 per lift	ASTM D2216
In-place dry unit weight	1 per lift	ASTM D1556, D2167, or D2937

Notes:
a. Tests for information only
b. Pass/fail tests
c. The average effective confining stress will be 5 psi.
d. Rapid turnaround tests (Method F–Constant Volume) will be used when possible.
e. Calibration check tests

TABLE 2-5
Minimum Frequency of Testing for CQA Evaluation of SBL

Test	Frequency	Standard Test Method
Bentonite		
Dry fineness	1 per lot	Technical specification [a]
High swelling	1 per lot	Technical specification
Processing		
Base soil excavation	Periodic monitoring	Observation
Base soil natural moisture content	1 per working day of hauling base material or per material color/consistency change	ASTM D2216
Base soil grain size	1 per working day of hauling base material or per material color/consistency change	ASTM D422
Bentonite/Base Soil application rate	1 per working day of admix processing	Measure weight of base soil and bentonite entering pugmill during a given period of time
Maximum clod size	Periodic monitoring	Observation
Curing [c]	1 per 12 hours	Observation
Pre-Compaction		
Lift thickness [d]	1 per 2,500 ft^2 per lift	Field measurement
Percent fines	1 per 1,000 yd^3 (minimum of 1 per day of placement)	ASTM D1140
Percent gravel	1 per 1,000 yd^3 (minimum of 1 per day of placement)	ASTM D422
Atterberg limits	1 per 1,000 yd^3 (minimum of 1 per day of placement)	ASTM D4318
Placement	Periodic monitoring	Observation
Post Compaction		
Lift thickness	5 per acre per lift	Full measurement
In place moisture content	5 per acre per lift	ASTM D3017
In place dry unit weight	5 per acre per lift	ASTM D2922
Shelby tube samples (laboratory permeability)	1 per acre per lift	ASTM D1587/ ASTM D5084 [e,f]
Number of passes [g]	Observe 1 per acre per lift	Observation
Construction oversight	Periodic monitoring	Observation
Calibration and Check		
Oven moisture content (per each nuclear gauge)	1 per 10 nuclear gauge moisture contents	ASTM D2216
Standard count calibration (per each nuclear gauge)	1 per day of placement	ASTM D2922/ASTM D3017

a. The test method is described in the technical specification.
b. Not used.
c. Curing is stockpiling the SBL material for 12 hours to allow the bentonite to hydrate.
d. A loose lift thickness is such that the compacted thickness is 6 inches or less.
e. The average effective confining stress will be 5 psi.
f. Rapid turnaround tests (Method F – Constant Volume) will be used when possible.
g. A single pass is defined as forward and back.

TABLE 2-6
Maximum Allowable Percentage of Failed Tests for CQA Evaluation of SBL

Test	Maximum percentage
Percent gravel	5 percent not concentrated in one lift or one area
Clod size	10 percent not concentrated in one lift or one area
In place moisture content	3 percent not concentrated in one lift or one area, and no water content less than 2 percent or more than 3 percent of the specified value
In place dry unit weight	3 percent not concentrated in one lift or one area, and no dry unit weight less than 5 pounds per cubic foot (pcf) below the specified value
Shelby tube samples (laboratory permeability)	5 percent not concentrated in one lift or one area

TABLE 2-7
Minimum Frequency of Testing for CQA Evaluation of Operations Layer

Test	Frequency	Standard Test Method
Material Properties		
Standard proctor or maximum index density for free-draining soil	1 per 20,000 yd^3 (minimum 1 per source or soil type)	ASTM D698 or ASTM D4253
Sieve analysis	1 per 10,000 yd^3 placed (minimum 1 per source)	ASTM D422
In-Place (Outside edge of liner only)		
In-place wet unit weight	1 per 5,000 ft^2 per lift	ASTM D2922, D1556
In-place moisture content	1 per 5,000 ft^2 per lift	ASTM D3017, D2216
In-Place (SLDS sump)		
In-place wet unit weight	2 per lift	ASTM D2922, D1556
In-place moisture content	2 per lift	ASTM D3017, D2216

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SECTION III–GEOSYNTHETIC CLAY LINER CONSTRUCTION QUALITY ASSURANCE

3.1 GEOSYNTHETIC CLAY LINER MANUFACTURE AND DELIVERY

3.1.1 Labeling

The CQA representative will verify and document that the GCL manufacturer has labeled each roll of GCL and includes the information required by the technical specifications. The CQA representative will examine GCL rolls upon delivery and deviation from the above requirements will be reported to the CQA certifying engineer prior to installation of the GCL.

3.1.2 Transportation and Handling

The CQA representative will observe and document that the type of GCL handling equipment used by the installer minimizes damage to the material. Upon delivery at the site, the CQA representative will conduct a visual inspection of all rolls for defects and for damage. This examination will be conducted without unrolling rolls unless visible defects or damages are found. The CQA representative will indicate to the CQA certifying engineer:

- Any rolls that need to be unrolled to allow for their inspection
- Any rolls, or portions thereof, that need to be rejected and removed from the site because they have severe flaws
- Any rolls that include minor repairable flaws

3.1.3 Storage

The CQA representative will verify and document that storage of the GCL is in accordance with the technical specifications.

3.1.4 Inventory

All geosynthetic materials that arrive onsite will be inventoried. The inventory will include the specific roll numbers delivered with each shipment. The inventory will be compared to the QC testing information, supplied by the manufacturer to ensure that the material tested is the same material that was delivered to the site. Material for which QC testing data has been supplied will be sampled for conformance testing. Conformance samples may be obtained by the CQA representative at the manufacturing plant or taken upon delivery of the material to the site by a CQA representative. As shipments arrive at the site, a CQA representative will monitor the unloading operations and will inventory the material. Rolls selected for conformance testing will be set aside for sampling as soon as possible.

The CQA representative will record the following information, at a minimum, for each roll:

- **Manufacturer**–Indicate the manufacturer of the material that is being inventoried, that may not be the same as the installer
- **Date of Inventory**–Date that the material was inventoried
- **Date of Delivery**–Enter date when the truck arrived onsite, if known
- **Truck Type**–Indicate type of truck used for shipping geosynthetics (covered or uncovered flatbed, box trailer)
- **Bill of Lading Number**–If the bill-of-lading is available, indicate number and date (also attach copy to inventory form)
- **CQA Representative**–Indicate name of CQA representative performing inventory
- **Unloading Equipment**–Indicate the type and model number of the equipment unloading the geosynthetic material; also note any special attachments that are used to unload the material (stinger, straps, forks)
- **Weather Conditions**–Describe the weather conditions, including temperature, wind, cloud cover, and precipitation during unloading and conformance sampling operation
- **Material Type**–Indicate type of geosynthetic material
- **Roll Number**–Indicate each roll number that is written on the roll (The roll numbers contain a variety of information regarding the material and the manufacturing process.)
- **Lot Number**–Lot number
- **Roll (L × W)**–Indicate the roll width as written on the roll label; if two materials are bonded together (i.e., geonet/geotextile), obtain measurements for both materials
- **Area (square feet)**–Indicate the total square footage of the roll
- **Damage Remarks**–Document any visible damage to the roll; if possible, indicate if damage was present prior to unloading or if it occurred during unloading

The CQA representative will immediately notify the IDF CM if a nonconforming or conditional use tag is attached to any of the inventoried items.

Items that are restricted from further use until the inspections have been completed will be clearly delineated by the CQA representative. Accepted materials will be kept separate or clearly delineated from inventoried and approved items, to the extent possible. The CQA representative will be responsible for coordinating with the construction general contractor during material delivery, so that the material is not moved more than necessary after it is unloaded and damage due to handling is minimized.

The CQA representative will perform the inventory immediately after the material arrives on the site to avoid delaying construction. The CQA representative will be responsible for verifying that only accepted material is installed at the IDF landfill and that all inventories and inspections are documented and maintained.

3.1.5 Quality Assurance Conformance Testing

Either at the manufacturer's plant or upon delivery of the rolls of GCL, the CQA representative will ensure that samples are removed at the specified frequency and forwarded to the Geosynthetics CQA Laboratory for testing, to verify and document conformance with the technical specifications.

Conformance samples will be taken across the entire width of the roll and will not include the first 3 feet along the length of the roll. Unless otherwise specified, samples will be 1.5 feet (minimum) long by the roll width. The CQA representative will mark the machine direction on the samples with an arrow.

Unless otherwise specified, samples will be taken at a rate of one per lot or one per 50,000 square feet, whichever is greater. These samples will be tested for:

- Index Flux (ASTM D5887)
- Bentonite Mass per Unit Area (ASTM D5993)
- Bentonite Swell Index Test (ASTM D5890)

The test will be conducted in accordance with the test procedure presented in the technical specifications.

The CQA representative will examine all results from laboratory conformance testing and compare the results to the specifications presented in the technical specifications. In addition, the CQA representative will report any non-conformance to the CQA certifying engineer as soon as practical after the test results become available.

The following procedure will apply whenever a sample fails a conformance test that is conducted by the Geosynthetics CQA Laboratory:

- The construction general contractor will be required to replace the roll (or rolls) of GCL not in conformance with the specifications with a roll that meets the requirements of the technical specifications.

- The CQA representative will ensure that conformance samples are removed for testing by the Geosynthetics CQA Laboratory from the closest numerical roll on both sides of the roll from which the failing sample was obtained. These two samples must pass the above conformance tests. If either of these samples fails to meet the requirements, samples will be collected from the five numerically closest untested rolls on both sides of the failed samples and tested by the Geosynthetics CQA Laboratory. These ten samples must pass the above conformance tests. If any of these samples fail, a sample from every roll of GCL onsite and a sample from every roll that is subsequently delivered from the same manufacturer must be conformance tested by the Geosynthetics CQA Laboratory until the manufacturer has thoroughly demonstrated compliance with the above requirements to the sole satisfaction of the CQA certifying engineer. The costs of all such tests are to be borne by the construction general contractor.

- The CQA representative will document actions taken in conjunction with conformance test failures as outlined in Section 8.1.4 and report all actions to the CQA certifying officer.

3.2 GEOSYNTHETIC CLAY LINER INSTALLATION

3.2.1 Surface Preparation

For fill surfaces that will underlay a GCL layer, the CQA representative will verify and document the following:

- The surface of the fill does not contain holes, ruts, protrusions, or other surface irregularities in excess of those dimensions specified by the technical specifications.
- The surface of the fill has been compacted to form a firm, stable base.
- The surface of the fill is free of any type of deleterious material that may cause damage to GCL, including debris, organic material, frozen soil, ice, and rocks.
- The surface of the fill is free of standing water or excessive moisture.
- The construction general contractor has certified in writing that the surface on which the GCL will be installed is acceptable.

The subgrade surface will be inspected immediately prior to commencement of GCL installation. If any change in the surface requires repair work, in accordance with the technical specifications, the construction general contractor will be responsible for repairing the fill surface.

A certificate of subgrade surface acceptance will be required from the construction general contractor. The CQA representative will verify that the subgrade is accepted by the GCL installer, immediately prior to commencement of GCL installation.

After the surface on which the GCL is to be installed has been accepted by the construction general contractor, it will be the CQA representative's responsibility to indicate to the CQA certifying engineer any change in the underlying layer that may, in accordance with the technical specifications, require repair work. If the CQA certifying engineer requires that repair work be done, it will be the responsibility of the construction general contractor to repair the underlying layer.

3.2.2 Anchor Trenches and Sumps

Prior to placement of geosynthetics in the anchor trenches or sumps, the CQA representative will verify and document the following:

- The sumps and anchor trenches are excavated to the grades and dimensions shown in the construction drawings. Any anomalies in the soil encountered during excavation will be brought to the attention of the IDF project engineer and removed as directed.
- The anchor trench excavation surface is prepared for installation of geosynthetics, with rounded corners, and free of loose soil or deleterious material.

After geosynthetics deployment into the anchor trench is complete, the CQA representative will verify and document that the backfill for the geosynthetic anchor trenches is placed and compacted in accordance with the technical specifications.

3.2.3 Geosynthetic Clay Liner Deployment

3.2.3.1 Field Panel Identification

A field panel is the unit area of GCL that is to be placed in the field (i.e., a field panel is a roll or a portion of roll cut in the field).

The CQA representative will track the placement location of each GCL panel by assigning an identification code (number or letter-number) or by an equivalent tracking method. The identification method will be agreed upon by the CQA certifying engineer and the construction general contractor. This field panel identification scheme will be as simple and logical as possible. (Note: manufacturing plant roll numbers are usually cumbersome and are not related to location in the field.) It will be the responsibility of the construction general contractor to ensure that each field panel placed is marked with the manufacturing plant roll number. The roll number will be marked in the center of the panel in a color to allow for easy inspection.

The CQA representative will establish a table or chart showing correspondence between manufacturing plant roll numbers and field panel identification codes. The field panel identification code will be used for all CQA records.

3.2.3.2 Field Panel Placement

Installation Schedule

The CQA representative will evaluate significant changes in the schedule, proposed by the construction general contractor, and will advise the CQA certifying engineer on the acceptability of that change. The CQA representative will verify and document that the condition of the underlying layer has not changed detrimentally during installation. Any damage to the surface of the underlying layer will be repaired by the construction general contractor, in accordance with the technical specifications.

Weather Conditions

The CQA representative will verify and document that GCL is not placed during inclement weather conditions, as specified in the technical specifications. Additionally, the CQA monitor will verify and document that the existing underlying layer has not been damaged by weather conditions.

Damage

The CQA representative will visually observe each panel, after placement, for damage. The CQA representative will inform the construction general contractor which panels, or portions of panels, are rejected, repaired, or accepted. Damaged panels or portions of damaged panels that have been rejected by the CQA representative will be marked, and their removal from the work area will be documented by the CQA representative.

Seam Overlap and Bentonite Seal

The construction general contractor will observe and document that the seam overlaps and bentonite material placed between panels, if required, along the seams meets specification guidelines. The CQA representative will verify overlap width and will observe bentonite seal placement.

3.2.3.3 Field Panel Protection

The CQA representative will observe and document that the GCL is completely covered with geomembrane or protective plastic cover at the end of each workday and protected from damage and hydration due to weather. The CQA representative will verify and document that equipment does not operate directly on the GCL and that a smooth rub sheet is used to maneuver textured geomembrane over the GCL to prevent damage to the GCL.

3.2.4 Defects and Repairs

Any defects and subsequent repairs will be documented, using NCR procedures outlined in Section 8.1.4.

3.2.4.1 Identification

All seams and non-seam areas of the GCL will be inspected by the CQA representative for evidence of defects, holes, contamination of geotextiles, displaced panels, premature hydration, and any sign of contamination by foreign matter. The CQA representative will observe and document repair procedures described below.

3.2.4.2 Repair Procedures

Prior to cover material placement, damage to the GCL will be identified and repaired by the installer.

Rip and Tear Repair (Flat Surfaces)
Rips or tears may be repaired by completely exposing the affected area, removing all foreign objects or soil, and by then placing a patch cut from unused GCL over the damage (damaged material may be left in place), with a minimum overlap of 12 inches on all edges.

Accessory bentonite will be placed between the patch edges and the repaired material at a rate of a quarter pound per lineal foot of edge, spread in a continuous 6 inch fillet.

Rip and Tear Repair (Slopes)
Damaged GCL material on slopes will be repaired by the same procedures as described above, however, the overlapped edges of the patch need to be wide enough to ensure the patch will keep its position during backfill or cover operations.

Displaced Panels
Displaced panels will be adjusted to the correct position and orientation. The adjusted panel will then be inspected for any geotextile damage or bentonite loss. Damage will be repaired by the above described procedure.

Premature Hydration
If the GCL is subjected to premature hydration, the construction general contractor will notify the CQA certifying engineer for a site-specific determination as to whether the material is acceptable or if alternative measures must be taken to ensure the quality of the design dependent upon the degree of damage.

SECTION IV–GEOMEMBRANE CONSTRUCTION QUALITY ASSURANCE

4.1 GEOMEMBRANE MATERIAL

4.1.1 Labeling

The CQA representative will verify and document that the geomembrane manufacturer has labeled each roll of geomembrane and includes the information required by the technical specifications. The CQA representative will examine geomembrane rolls upon delivery and deviation from the requirements will be reported to the CQA certifying engineer, prior to installation of the geomembrane.

4.1.2 Transportation and Handling

Upon delivery at the site, the CQA representative will conduct a visual inspection of all rolls for defects and damage. This examination will be conducted without unrolling rolls unless visible defects or damage are found. The CQA representative will indicate the following to the CQA certifying engineer:

- Any rolls that need to be unrolled to allow for their inspection
- Any rolls, or portions thereof, that need to be rejected and removed from the site because they have severe flaws
- Any rolls that include minor repairable flaws

4.1.3 Storage

The CQA representative will verify and document that storage of the geomembrane is in accordance with the technical specifications.

4.1.4 Inventory

All geosynthetic materials that arrive onsite will be inventoried in accordance with the technical specifications. The inventory will include the specific roll numbers delivered with each shipment. The inventory will be compared to the QC testing information supplied by the manufacturer to ensure that the material tested is the same material that was delivered to the site. Material for which QC testing data has been supplied will be sampled for conformance testing. Conformance samples may be obtained by the CQA representative at the manufacturing plant or taken upon delivery of the material to the site by a CQA representative. As shipments arrive at the site, a CQA representative will monitor the unloading operations and will inventory the material. Rolls selected for conformance testing will be set aside for sampling as soon as possible.

The CQA representative will record the following information, at a minimum, for each roll:

- **Manufacturer**–indicate the manufacturer of the material that is being inventoried, that may not be the same as the installer
- **Date of Inventory**–Date that the material was inventoried
- **Date of Delivery**–Enter date when the truck arrived onsite, if known
- **Truck Type**–Indicate type of truck used for shipping geosynthetics (covered or uncovered flatbed, box trailer)
- **Bill-of-Lading Number**–If the bill-of-lading is available, indicate number and date (also attach copy to inventory form)
- **CQA Representative**–Indicate name of CQA representative performing inventory
- **Unloading Equipment**–Indicate the type and model number of the equipment unloading the geosynthetic material; also note any special attachments that are used to unload the material (stinger, straps, forks)
- **Weather Conditions**–Describe the weather conditions, including temperature, wind, cloud cover, and precipitation during unloading and conformance sampling operation
- **Material Type**–Indicate type of geosynthetic material (HDPE, geotextile, or geonet)
- **Roll Number**–Indicate each roll number that is indicated on the roll (The roll numbers contain a variety of information regarding the material and the manufacture process.)
- **Lot Number**–Lot number as indicated
- **Roll (L × W)**–Indicate the roll width as indicated on the roll label; if two materials are bonded together (i.e., geonet/geotextile), obtain measurements for both materials
- **Area (square feet)**–Indicate the total square footage of the roll
- **Damage Remarks**–Document any visible damage to the roll; if possible, indicate if damage was present prior to unloading or if it occurred during unloading

Items that are restricted from further use until the inspections have been completed will be clearly delineated by the CQA representative. Accepted materials will be kept separate or clearly delineated from inventoried and approved items to the extent possible. The CQA representative will be responsible for coordinating with the construction general contractor during material delivery, so that the material is not moved more than necessary after it is unloaded and damage due to handling is minimized.

The CQA representative will perform the inventory immediately after the material arrives onsite to avoid delaying construction. The CQA representative will be responsible for verifying that only accepted material is installed at the IDF landfill, and that all inventories and inspections are documented and maintained.

4.1.5 Quality Assurance Conformance Testing

Either at the manufacturer's plant or upon delivery of the rolls of geomembrane, the CQA representative will ensure that samples are removed at the specified frequency and forwarded to the Geosynthetics CQA Laboratory for testing to verify and document conformance with the technical specifications.

Conformance samples will be taken by the CQA representative across the entire width of the roll and will not include the first 3 feet. Unless otherwise specified, samples will be 3 feet (minimum) long by the roll width. The CQA representative will mark the direction of the machine used to cut the samples with an arrow.

Unless otherwise specified, samples will be taken at a rate of one per lot or one per 50,000 square feet, whichever is greater. These samples will be tested for:

- Thickness (ASTM D5199 or D5994)
- Tensile characteristics (yield strength and elongation at yield, ASTM D638)
- Asperity (GRI GM-12)
- Puncture resistance (ASTM D4833)

Test will be conducted in accordance with the test procedure presented in the technical specifications. The CQA representative will examine all results from laboratory conformance testing and will report any non-conformance after the test results become available. The following procedure will apply whenever a sample fails a conformance test that is conducted by the CQA representative:

- The construction general contractor will be required to replace the roll (or rolls) of geomembrane in non-conformance with the technical specifications with a roll that meets the technical specifications.

- The CQA certifying engineer will ensure that conformance samples are removed for testing by the Geosynthetics CQA Laboratory from the closest numerical roll on both sides of the failed roll. These two samples must pass the above conformance tests. If either of these samples fail, samples will be collected from the five numerically closest untested rolls on both sides of the failed sample and tested by the Geosynthetics CQA Laboratory. These ten samples must pass the above conformance tests. If any of these samples fail, a sample from every roll of geomembrane onsite and every roll subsequently delivered from the same manufacturer must be conformance tested by the Geosynthetics CQA Laboratory, until the manufacturer has thoroughly demonstrated compliance with the above requirements to the sole satisfaction of the CQA certifying engineer. The costs of all such tests are to be borne by the construction general contractor.

4.1.6 Manufacturing Plant Site Visit

The manufacturer shall allow the CQA certifying engineer or his designated representative to visit the manufacturing plant, if the CQA certifying engineer so chooses. If possible, the visit shall be prior to or during the manufacturing of the geomembrane rolls for the specific project. The CQA Engineer or his designated representative shall review the manufacturing process, quality control, laboratory facilities, and testing procedures as described in the technical specifications (see Section 02661).

4.2 GEOMEMBRANE INSTALLATION

4.2.1 Surface Preparation

For SBL surfaces that will underlay a geomembrane layer, the CQA representative will verify and document the following:

- The surface of the subgrade or SBL does not contain holes, depressions, or protrusions in excess of those dimensions specified by the technical specifications.
- The surface of the subgrade or SBL has been rolled with a smooth-drum roller to form a firm stable base without ridges, wheel ruts, and surface irregularities.
- The surface of the subgrade or SBL is free of any type of deleterious material that may cause damage to geomembrane.
- The construction general contractor has certified in writing that the surface on which the geomembrane will be installed is acceptable.

The subgrade and SBL surface will be inspected immediately prior to commencement of geomembrane installation. If any change in the surface requires repair work, in accordance with the technical specifications, the construction general contractor will be responsible for repairing the surface. A certificate of subgrade surface acceptance will be required from the construction general contractor. The CQA representative will verify that the subgrade is accepted by the geomembrane installer immediately prior to commencement of geomembrane installation.

After the surface on which the geomembrane is to be installed has been accepted by the construction general contractor, it will be the CQA representative's responsibility to indicate to the CQA certifying engineer any change in the underlying layer that may, in accordance with the technical specifications, require repair work. If the CQA certifying engineer requires that repair work be done, it will be the responsibility of the construction general contractor to repair the underlying layer.

4.2.2 Anchor Trenches and Sumps

Prior to placement of geosynthetics in the anchor trenches or sumps, the CQA representative will verify and document the following:

- The excavation of the sumps and anchor trenches is performed in accordance with the technical specifications. Any anomalies in the soil encountered during excavation will be brought to the attention of the IDF project engineer and removed as directed.

- The anchor trench excavation surface is prepared for installation of geosynthetics with rounded corners and is free of loose soil or deleterious material.

After geosynthetics deployment into the anchor trench is complete, the CQA representative will verify and document that the backfill for the geosynthetic anchor trenches is placed and compacted in accordance with the technical specifications and construction drawings.

4.2.3 Geomembrane Deployment

4.2.3.1 Layout Drawing

The construction general contractor will be required to produce layout drawings that show the geomembrane panel configuration, dimensions, details, and seam locations. The layout drawings must be approved by the CQA certifying engineer, prior to the installation of the geomembrane.

4.2.3.2 Field Panel Identification

A field panel is the unit area of geomembrane that is to be seamed in the field (i.e., a field panel is a roll or a portion of roll cut in the field).

The CQA representative will verify that each field panel is given an identification code (number or letter-number) consistent with the layout plan. This identification code will be agreed upon by the CQA representative and the construction general contractor. This field panel identification code will be as simple and logical as possible. (Note: manufacturing plant roll numbers are usually cumbersome and are not related to location in the field.) It will be the responsibility of the construction general contractor to ensure that each field panel placed is marked with the manufacturing plant roll number. The roll number will be marked in the center of the panel in a color to allow for easy inspection.

The CQA representative will establish a table or chart showing correspondence between manufacturing plant roll numbers and field panel identification codes. The field panel identification code will be used for all CQA records.

4.2.3.3 Field Panel Placement

Location

The CQA representative will verify and document that field panels are installed at the locations and positions indicated in the construction general contractor's layout plan, as approved or modified by the CQA certifying engineer.

Installation Schedule

The CQA representative will evaluate significant changes in the schedule, proposed by the construction general contractor, and will advise the CQA certifying engineer on the acceptability of that change. The CQA representative will verify and document that the condition of the underlying layer has not changed detrimentally during installation. Any damage to the surface of the underlying layer will be repaired by the construction general contractor in accordance with the technical specifications.

The CQA representative will record the identification code, location, and date of installation of each field panel.

Weather Conditions
The CQA representative will verify and document that geomembrane is not placed during inclement weather conditions, as specified in the technical specifications. Additionally, the CQA representative will verify and document that the underlying layer has not been damaged by weather conditions.

Damage
The CQA representatives will visually observe each panel, after placement and prior to seaming, for damage (e.g., holes, blisters, and creases). The CQA representative will inform the construction general contractor which panels, or portions of panels, need to be rejected, repaired, or accepted. Damaged panels or portions of damaged panels that have been rejected by the CQA certifying engineer will be marked, and their removal from the work area will be documented by the CQA representative, using the NCR procedures outlined in Section 8.1.4.

4.2.4 Field Seaming

4.2.4.1 Seam Layout

The CQA certifying engineer will verify and document that the seam layout shown in the panel layout drawing is consistent with the technical specifications. A seam numbering system compatible with the panel numbering system will be agreed upon by the construction general contractor and CQA certifying engineer.

4.2.4.2 Seaming Equipment and Products

Processes approved by the technical specifications for field seaming are extrusion seaming; and fusion seaming. Proposed alternate processes will be required to be documented and submitted to the CQA certifying engineer for approval. The construction general contractor will be required to use a pyrometer to ensure that accurate temperatures of the extrudate and seamer nozzle are being achieved.

The extrusion seaming apparatus will be equipped with gauges, indicating the temperatures of the extrudate and nozzle. The construction general contractor will be required to provide to the CQA certifying engineer the manufacturer's certification that the extrudate is compatible with the geomembrane material and is comprised of the same resin as the geomembrane.

The CQA representative will log ambient temperatures, seaming apparatus temperatures, and extrudate temperatures or fusion seaming apparatus speeds. Ambient temperatures will be measured to verify compliance with the technical specifications.

4.2.4.3 Seam Preparation

The CQA certifying engineer will verify and document the following:

- Prior to seaming, the seam area is clean and free of moisture, dust, dirt, debris, and foreign material.
- Preparation of seams is in accordance with the technical specifications.

4.2.4.4 Weather Conditions for Seaming

The CQA representative will verify and document that weather conditions for seaming are within the limits specified in the technical specifications.

4.2.4.5 Trial Seams

The construction general contractor will be required to make trial seams on fragment pieces of geomembrane liner to verify that seaming conditions are adequate. The construction general contractor will be required to make and test trial seams at the frequency and in accordance with the methods specified in the technical specifications.

The CQA representative will observe all trial seam procedures. The trial seam samples will be assigned a number and marked accordingly by the CQA representative, along with the date, hour, ambient temperature, number of seaming unit, name of seamer, and pass or fail description. A sample of the trial seam will be retained by the CQA team until the construction of the liner is complete and the liner has been accepted by the CQA certifying engineer.

4.2.4.6 Nondestructive Seam Continuity Testing

Except as otherwise noted in the technical specifications, the construction general contractor will nondestructively test all field seams over their full length, in accordance with the technical specifications. The purpose of nondestructive tests is to check the continuity of seams. Continuity testing will be carried out as the seaming work progresses, not at the completion of all field seaming. Nondestructive testing will not be permitted before sunrise or after sunset unless the construction general contractor demonstrates to the CQA certifying engineer that the construction general contractor has the capabilities to perform continuity testing under reduced light conditions. The CQA representative will perform the following tasks:

- Observe the continuity testing
- Record location, date, test unit number, name of tester, and outcome of all testing
- Document and inform the construction general contractor of any required repairs

The construction general contractor will be required to complete any required repairs, in accordance with the technical specifications. The CQA representative will perform the following tasks:

- Observe the repair and re-testing of the repair
- Mark on the geomembrane that the repair has been made
- Document the results

The CQA representative will verify and document the procedures specified in the technical specifications where seams cannot be nondestructively tested. The location, date of visual observation, name of tester, and outcome of the test or observation will be recorded by the CQA representative and reported to the CQA certifying engineer.

4.2.4.7 Destructive Seam Testing

Concept

Destructive seam tests will be performed at selected locations. The purpose of these tests is to evaluate seam strength and integrity. Seam strength testing will be done as the seaming work progresses, not at the completion of all field seaming.

Location and Frequency

The CQA representative will select locations where seam samples will be cut out for laboratory testing at the frequency specified in the technical specifications (see Section 02661). In general, destructive tests will be located in non-critical areas, such as seam run-out areas or near three-panel intersections or other areas that will require a patch anyway. In addition, because extrusion welding may be limited on a daily basis, extrusion destructive samples may be welded after passing a trial seam on scrap material not used for construction. However, when significant lengths (greater than 100 feet) of seams or caps are extrusion welded, a destructive test of the weld will be taken.

Control charts will be used to track the performance of each welding machine and technician to allow for biased sampling, according to performance. An upper control limit (UCL) will be established to statistically identify the sources of test failures. Machines and technicians whose failure rates exceed the UCL will then be identified and destructively tested at twice the original frequency (one per 250 feet of seam length) to better monitor their performance. Once the failure rate drops back into compliance with the UCL, the original testing frequency will be reinstated. Machines and technicians whose failure notes are below the UCL will be identified to decrease the original frequency, as approved by the CQA certifying engineer.

The UCL is established based on the failure rate for all destructive tests plus three standard deviations with a ceiling of 3.5 percent. The ceiling is the maximum failure rate determined to be acceptable, as agreed upon jointly by the construction general contractor and CQA certifying engineer. The initial UCL will be calculated once a single machine or technician fails two destructive tests and will typically be updated daily with the most recent destructive testing results. Destructive tests tracking a failed destructive will not be included in the calculation of the failure rates.

Additional destructive test locations may be required during seaming operations. The necessity for such additional sampling and testing will be determined by CQA representatives and will be implemented when there is cause to suspect the presence of excess crystallinity, contamination, offset welds, or any other reason to suspect potentially defective seams. The location selection of the additional testing will be based on the CQA representative's judgment and observation of a suspected problem.

The construction general contractor will not be informed in advance of the locations where the seam samples will be taken.

Sampling Procedure
The construction general contractor will be required to cut samples, as directed by the CQA representative as the seaming progresses, in order to have laboratory test results before the geomembrane is covered by another material. The CQA representative will perform the following tasks:

- Observe sample cutting
- Assign a number to each sample and mark it accordingly
- Record the sample number and location on the panel layout drawing
- Record the reason for taking the sample at this location (e.g., routine testing, suspicious feature of the geomembrane)

All holes in the geomembrane resulting from destructive seam sampling will be covered by the construction general contractor immediately after sampling and will be repaired in accordance with the repair procedures described in the technical specifications. The continuity of the new seams in the repaired area will be nondestructively tested, according to the technical specifications.

Size of Samples
At a given sampling location, two types of samples will be taken by the construction general contractor. First, two specimens for field testing will be taken. Each of these specimens will be 1 inch wide by 6 to 12 inches long, with the seam centered parallel to the width. The distance between these two specimens will be approximately 42 inches. If both specimens pass the field test described in the technical specifications, a sample for laboratory testing will be taken.

The sample for laboratory testing will be required to be taken between the two specimens for field testing. The destructive sample will be 12 inches wide by 42 inches long, with the seam centered lengthwise. The sample will be cut into three parts and distributed as follows:

- One portion to the construction general contractor, 12 inches long
- One portion to the IDF CM for archive storage, 12 inches long
- One portion to the CQA certifying engineer for CQA Laboratory testing, 18 inches long

Final determination of the sample sizes will be made at the preconstruction meeting.

Field Testing
The two 1-inch-wide specimens, as specified above, will be required to be tested in the field by the CQA representative by tensiometer for peel and shear and need to not fail in the seam. If any field test sample fails to pass, the procedures outlined in the technical specifications will be followed.

The CQA representative will mark all samples and portions with their number, date, and time.

Geosynthetic Construction Quality Assurance Laboratory Testing

Laboratory destructive test samples will be packaged and shipped to the Geosynthetics CQA Laboratory by the CQA representative in a manner that will not damage the test sample. The CQA representative will store the archive samples until the completion of the project.

Testing will include "Shear Strength" and "Peel Strength" (ASTM D6392) with 1-inch-wide strip, tested at 2 inches per minute. The minimum acceptable values to be obtained in these tests are those indicated in the technical specifications. At least five specimens will be tested for each test method. Specimens will be selected alternately by test from the samples (i.e., peel, shear, peel, shear). At least four out of five of the specimens for each test must pass.

The laboratory will provide test results verbally to the CQA certifying engineer in a timely manner after they receive and test the samples. The CQA certifying engineer will review laboratory test results as soon as they become available and will inform the CQA certifying engineer of the test results.

Procedures for Destructive Test Failure

The procedures specified in the technical specifications will be required whenever a sample fails a destructive test, whether that test is conducted by the Geosynthetics CQA Laboratory or by field tensiometer. The CQA certifying engineer will verify and document that one of the options specified in the technical specifications is followed. The CQA representative will document all actions taken in conjunction with destructive test failures, including preparation of NCRs, as outlined in Section 8.1.4.

4.2.5 Defects and Repairs

4.2.5.1 Identification

All seams and non-seam areas of the geomembrane will be inspected by the CQA representative for evidence of defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter. Because light reflected by the geomembrane helps to detect defects, the surface of the geomembrane will be required to be clean at the time of examination. The geomembrane surface will be required to be swept or washed by the construction general contractor if the amount of dust or mud inhibits examination.

4.2.5.2 Evaluation

Each suspect location both in seam and non-seam areas will be required to be either non-destructively tested using the methods described in the technical specifications, or repaired as appropriate as determined by the CQA certifying engineer. Each location that fails the non-destructive testing will be marked by the CQA representative and will be required to be repaired by the construction general contractor. Materials will not be placed over geomembrane locations that have been repaired until the CQA representative has approved the repair.

4.2.5.3 Large Wrinkles

When seaming of the geomembrane is completed (or when seaming of a large area of the geomembrane is completed) and prior to placing overlying materials, the CQA representative will visually inspect the geomembrane for wrinkles. Based on the requirements of the technical specifications, the CQA representative will indicate to the construction general contractor which wrinkles, if any, are to be cut, overlapped, and seamed to remove the wrinkle. The seam thus produced will be tested like any other seam.

4.2.5.4 Repair Procedures

Any portion of the geomembrane either exhibiting a flaw or failing a destructive or nondestructive test will be repaired by the construction general contractor in accordance with the applicable method specified in the technical specifications. An NCR will be prepared to document all flaws and failed tests, as outlined in Section 8.1.4. Each repair will be located and logged by the CQA representative.

4.2.5.5 Testing of Repairs

Each repair will be non-destructively tested, using the methods described in the technical specifications as appropriate. Repairs that pass the non-destructive test will be considered adequate. Large caps may be of sufficient extent to require destructive testing, at the discretion of the CQA certifying engineer. Failed tests will require the repair to be redone and re-tested until passing test results are obtained. The CQA representative will observe the non-destructive testing of repairs and will document the date of the repair and test outcome.

4.2.6 Appurtenances

The CQA representative will verify and document the following:

- Installation of the geomembrane around, and connection of geomembrane to, appurtenances have been made according to the technical specifications or manufacturer's recommendations.
- Extreme care is taken while seaming around appurtenances, since neither non-destructive nor destructive testing may be feasible in these areas.
- The geomembrane has not been visibly damaged while being connected to appurtenances.

The CQA representative will inform the CQA certifying engineer if the above conditions are not fulfilled.

4.3 GEOMEMBRANE PANEL LAYOUT SURVEY

A survey will be performed by or under the direction of a professional land surveyor registered in the State of Washington. The surveyor will independently survey the elevations and location of each panel intersection and destructive sample. The results of the survey conducted by the surveyor will be compiled in a report signed by the surveyor and the CQA certifying engineer.

The surveyor will be required to survey each geomembrane panel intersection and destructive sample location for the IDF landfill, in accordance with the requirements of this CQA Plan. A record drawing will be submitted to the CQA certifying engineer by the surveyor. The survey will include enough information to confirm that the geomembrane layout is in accordance with the panel layout and include, but not be limited to, the following information:

- Geomembrane panel intersections
- Destructive sample location and identification
- Edge of geomembrane liner
- Panel identification numbers

Each geomembrane layer will be surveyed including, but not be limited to:

- Secondary leak detection system geomembrane
- Secondary geomembrane
- Primary geomembrane

4.4 LAYER COMPLETION CERTIFICATION

The construction general contractor will be required to notify the CQA representative when an area of geomembrane is complete, prior to constructing the overlying layer. The construction general contractor may place overlying layer after acceptance of geomembrane layer by the CQA Certifying Engineer. The CQA certifying engineer will provide a certificate of layer completion to the construction general contractor and the IDF project engineer, certifying that all CQA tests are complete and all defects have been repaired and tested.

SECTION V–GEOTEXTILE CONSTRUCTION QUALITY ASSURANCE

5.1 GEOTEXTILE MATERIAL AND INSTALLATION

5.1.1 Labeling

The CQA representative will verify and document that the geotextile manufacturer has labeled all rolls of geotextile with the information specified in the technical specifications. The CQA representative will examine rolls upon delivery, and any deviation from the requirements will be reported to the CQA certifying engineer. Geotextile rolls that are not labeled or that have illegible labels will be removed and disposed by the construction general contractor.

5.1.2 Transportation and Handling

The CQA representative will observe rolls of geotextile upon delivery at the site, and any deviation from the transportation and handling requirements specified in the technical specifications will be reported to the CQA certifying engineer. Any damaged rolls will be rejected by the CQA certifying engineer and required to be repaired or replaced by the construction general contractor.

5.1.3 Storage

The CQA representative will verify and document that storage of the geotextile is in accordance with the technical specifications.

5.1.4 Inventory

All geotextile materials that arrive onsite will be inventoried. The inventory will include the specific roll numbers delivered with each shipment. The inventory will be compared to the QC testing information, supplied by the manufacturer to ensure that the material tested is the same material that was delivered to the site. Material for which QC testing data has been supplied will be sampled for conformance testing. Conformance samples may be obtained by the CQA representative at the manufacturing plant or taken upon delivery of the material to the site by a CQA representative.

As shipments arrive at the site, a CQA representative will monitor the unloading operations and will inventory the material. Rolls selected for conformance testing will be set aside for sampling as soon as possible.

The CQA representative will record the following information, at a minimum, for each roll:

- **Manufacturer**–Indicate the manufacturer of the material that is being inventoried, that may not be the same as the installer
- **Date of Inventory**–Date that the material was inventoried
- **Date of Delivery**–Enter date when the truck arrived onsite, if known
- **Truck Type**–Indicate type of truck used for shipping geosynthetics (covered or uncovered flatbed, box trailer)
- **Bill-of-Lading Number**–If the bill-of-lading is available, indicate number and date (also attach copy to inventory form)
- **CQA Representative**–Indicate name of CQA representative performing inventory
- **Unloading Equipment**–Indicate the type and model number of the equipment unloading the geosynthetic material; also note any special attachments that are used to unload the material (stinger, straps, forks)
- **Weather Conditions**–Describe the weather conditions, including temperature, wind, cloud cover, and precipitation during unloading and conformance sampling operation
- **Material Type**–Indicate type of geosynthetic material
- **Roll Number**–Indicate each roll number that is indicated on the roll
- **Lot Number**–Lot number
- **Roll (L x W)**–Indicate the roll width as indicated on the roll label; if two materials are bonded together (i.e., geonet/geotextile), obtain measurements for both materials
- **Area (square feet)**–Indicate the total square footage of the roll
- **Damage Remarks**–Document any visible damage to the roll; if possible, indicate if damage was present prior to unloading or if it occurred during unloading

Items that are restricted from further use until the inspections have been completed will be clearly delineated by the CQA representative. Accepted materials will be kept separate or clearly delineated from inventoried and approved items to the extent possible. The CQA representative will coordinate with the construction general contractor during material delivery so that the material is not moved more than necessary after it is unloaded and damage due to handling is minimized.

The CQA representative will perform the inventory immediately after the material arrives onsite to avoid delaying construction. The CQA representative will be responsible for verifying that only accepted material is installed at the IDF landfill and that all inventories and inspections are documented and maintained.

5.1.5 Conformance Testing

Either at the manufacturer's factory or upon delivery of the geotextile rolls, the CQA representative will ensure that samples are removed and forwarded to the Geosynthetics CQA Laboratory for testing to verify and document conformance with the requirements of the technical specifications. Conformance samples will be taken across the entire width of the roll and will not include the first 3 feet along the edge of the roll. Unless otherwise specified, samples will be 3 feet (minimum) long by the roll width. The CQA representative will mark the machine direction on the samples with an arrow.

Samples will be taken at a rate of one per material lot or one per 50,000 square foot, whichever is greater. These samples will be tested for the following:

- Permittivity (ASTM D4491, Type 1 only)
- Grab strength (ASTM D4632)
- Tear strength (ASTM D4533)
- Puncture strength (ASTM D4833)

The CQA representative will examine all results of laboratory conformance testing and report any non-conformance to the CQA certifying engineer as soon as results become available. The following procedure will apply whenever a sample fails a conformance test that is conducted by the Geosynthetics CQA Laboratory:

- The construction general contractor will replace the roll (or rolls) of geotextile not in conformance with the specifications with a roll that meets the requirements of the technical specifications.

- The CQA representative will ensure that conformance samples are removed for testing by the Geosynthetics CQA Laboratory from the closest numerical roll on both sides of the roll from which the failing sample was obtained. These two samples must pass the above conformance tests. If either of these samples fail to meet the requirements, samples will be collected from the five numerically closest untested rolls on both sides of the failed sample and tested by the Geosynthetics CQA Laboratory. These ten samples must pass the above conformance tests. If any of these samples fail, a sample from every roll of geotextile onsite and a sample from every roll that is subsequently delivered from the same manufacturer must be conformance tested by the Geosynthetics CQA Laboratory, until the manufacturer has thoroughly demonstrated compliance with the above requirements to the sole satisfaction of the CQA certifying engineer. The cost of all such tests are to be borne by the construction general contractor.

The CQA representative will document actions taken in conjunction with conformance test failures and report all actions taken to the CQA certifying engineer. Failed tests will be documented using NCR procedures, outlined in Section 8.1.4.

5.1.6 Deployment

The construction general contractor will be required to handle all geotextile material in such a manner as to ensure that it is not damaged in any way.

It will be the CQA representative's responsibility to indicate to the CQA certifying engineer any change in the underlying layer that may, in accordance with the technical specifications, require repair work. If the CQA certifying engineer requires that repair work be done, it will be the responsibility of the construction general contractor to repair the underlying layer.

The CQA representative will verify and document compliance with the following:

- Just prior to geotextile placement, the layer that underlies the geotextile, if it is a geosynthetic, is clean and free of excessive amounts of dust, dirt, stones, rocks, or other obstructions that could potentially damage the liner system.
- In the presence of excessive wind, the geotextile is weighted with sandbags (or equivalent weight approved by the CQA representative).
- Geotextile is kept under tension to minimize the presence of wrinkles in the geotextile. If necessary, the geotextile is positioned by hand after being unrolled to minimize wrinkles.
- Geotextile is cut using a geotextile cutter approved by the geotextile manufacturer and the CQA representative. If in place, special care is taken to protect other materials (such as underlying geosynthetics) from damage that could be caused by the cutting of the geotextiles.
- The construction general contractor takes any necessary precautions to prevent damage to the underlying layers during placement of the geotextile.
- During placement of geotextile, care is taken not to entrap stones, excessive dust, or moisture that could damage the underlying layers, generate clogging of drains or filters, or hamper subsequent seaming.
- Geotextile is not left exposed for an excess of 14 days after placement, to prevent damage from exposure to ultraviolet radiation (sunlight). If the geotextile is exposed for more than 14 days, a temporary cover may be deployed for the duration of the delay or samples may be submitted to an independent testing laboratory to ensure that detrimental levels of UV degradation have not occurred. Test results shall be submitted to CQA certifying engineer for review and approval. Detrimental level of UV degradation is defined in the technical specifications (see Section 02371).

The CQA representative will document any non compliance with the above requirements and report them to the CQA certifying engineer.

5.1.7 Seams and Overlaps

The CQA representative will verify and document that all geotextile seams are oriented and overlapped, in accordance with the technical specifications. The construction general contractor will be required to pay close attention at seams to ensure that no protective soil layer material could be inadvertently placed beneath the geotextile.

5.1.8 Repair

The CQA representative will verify and document that any holes or tears in the geotextile are repaired, in accordance with the requirements of the technical specifications. The CQA representative will document any noncompliance with the above requirements and report it to the CQA certifying engineer.

SECTION VI–COMPOSITE DRAINAGE NET CONSTRUCTION QUALITY ASSURANCE

6.1 COMPOSITE DRAINAGE NET MATERIAL AND INSTALLATION

6.1.1 Labeling

The CQA representative will verify and document that the composite drainage net manufacturer has labeled all rolls of composite drainage net as specified in the technical specifications. The CQA representative will examine rolls upon delivery, and any deviation from the above requirements will be reported to the CQA certifying engineer prior to installation of the composite drainage net.

6.1.2 Transportation and Handling

The CQA representative will observe rolls of composite drainage net upon delivery at the site, and any deviation from the requirements of the technical specifications will be reported to the CQA certifying engineer. Any damaged rolls will be rejected by the CQA representative and be required to be repaired or replaced by the construction general contractor.

6.1.3 Storage

The CQA representative will verify and document that the storage of the composite drainage net is in accordance with the technical specifications.

6.1.4 Inventory

All CDN that arrive onsite will be inventoried. The inventory will record the specific roll numbers delivered with each shipment. The inventory will be compared to the QC testing information supplied by the manufacturer, to ensure that the material tested is the same material that was delivered to the site. Material for which QC testing data has been supplied will be sampled for conformance testing. Conformance samples may be obtained by the CQA representative at the manufacturing plant or taken upon delivery of the material to the site by a CQA representative.

As shipments arrive at the site, a CQA representative will monitor the unloading operations and will inventory the material. Rolls selected for conformance testing will be set aside for sampling as soon as possible.

The CQA representative will record the following information, at a minimum, for each roll:

- **Manufacturer**–Indicate the manufacturer of the material that is being inventoried, that may not be the same as the installer
- **Date of Inventory**–Date that the material was inventoried
- **Date of Delivery**–Enter date when the truck arrived onsite, if known
- **Truck Type**–Indicate type of truck used for shipping geosynthetics (covered or uncovered flatbed, box trailer)
- **Bill-of-Lading Number**–If the bill-of-lading is available, indicate number and date (also attach copy to inventory form)
- **CQA Representative**–Indicate name of CQA representative performing inventory
- **Unloading Equipment**–Indicate the type and model number of the equipment unloading the geosynthetic material; also note any special attachments that are used to unload the material (stinger, straps, forks)
- **Weather Conditions**–Describe the weather conditions, including temperature, wind, cloud cover, and precipitation during unloading and conformance sampling operation
- **Material Type**–Indicate type of geosynthetic material (high-density polyethylene, geotextile, or geonet)
- **Roll Number**–Indicate each roll number that is written on the roll
- **Lot Number**–Lot number as indicated
- **Roll (L × W)**–Indicate the roll width as indicated on the roll label; if two materials are bonded together (i.e., geonet/geotextile), obtain measurements for both materials
- **Area (square feet)**–Indicate the total square footage of the roll
- **Damage Remarks**–Document any visible damage to the roll; if possible, indicate if damage was present prior to unloading or if it occurred during unloading

Items that are restricted from further use until the inspections have been completed will be clearly delineated by the CQA representative. Accepted materials will be kept separate or clearly delineated from inventoried and approved items to the extent possible. The CQA representative will coordinate with the construction general contractor during material delivery so that the material is not moved more than necessary after it is unloaded and damage due to handling is minimized.

The CQA representative will perform the inventory immediately after the material arrives onsite to avoid delaying construction. The CQA representative will be responsible for verifying that only accepted material is installed at the IDF landfill and that all inventories and inspections are documented and maintained.

6.1.5 Conformance Testing

Either at the manufacturer's plant or upon delivery of the composite drainage net rolls, the CQA representative will ensure that samples are removed and forwarded to the Geosynthetics CQA Laboratory for testing, to verify and document conformance with the requirements of the technical specifications.

Conformance samples will be taken across the entire width of the roll and will not include the first 3 feet. Unless otherwise specified, samples will be 3 feet long (minimum) by the roll width. The CQA representative will mark the machine direction on the samples with an arrow.

Samples will be taken at a rate of one per lot or one per 50,000 square feet, except as noted otherwise below, whichever is greater. The geonets will be tested for the following:

- Polymer specific gravity (ASTM D1505)
- Thickness (ASTM D5199)
- Nominal transmissivity (ASTM D4716 – one per production lot)

The composite drainage nets will be tested for the following:

- Adhesion (GRI-GC7 or ASTM D413)
- Transmissivity (ASTM D4716 – one per production lot)

The CQA representative will examine all results from laboratory conformance testing and will report any non-conformance to the CQA certifying engineer as soon as the results become available.

The following procedure will apply whenever a sample fails a conformance test that is conducted by the Geosynthetics CQA Laboratory:

- The construction general contractor will be required to replace the roll (or rolls) of composite drainage net not in conformance with the specifications with a roll that meets the requirements of the technical specifications.

- The CQA representative will ensure that conformance samples are removed for testing by the Geosynthetics CQA Laboratory from the closest numerical roll on both sides of the failed roll. These two samples must pass the above conformance tests. If either of these samples fail, samples will be collected from the five numerically closest untested rolls on both sides of the failed sample and tested by the Geosynthetics CQA Laboratory. These ten samples must pass the above conformance tests. If any of these samples fail, a sample from every roll of composite drainage net onsite and a sample from every roll that is subsequently delivered from the same manufacturer must be conformance tested by the Geosynthetics CQA Laboratory, until the manufacturer has thoroughly demonstrated compliance with the above requirements to the sole satisfaction of the CQA certifying engineer. The cost of such tests is to be borne by the construction general contractor.

The CQA representative will document actions taken in conjunction with conformance test failures and report all actions to the CQA certifying engineer. Failed tests will be documented using NCR procedures, outlined in Section 8.1.4.

6.1.6 Deployment

The construction general contractor will be required to handle all composite drainage net in such a manner as to ensure that it is not damaged.

The construction general contractor (responsible for composite drainage net installation) will be required to certify in writing that the surface on which the composite drainage net will be installed is complete and acceptable. A certificate of partial completion will be given by the construction general contractor to the CQA representative, who will then verify to the CQA certifying engineer that the deployment surface is complete, prior to commencement of composite drainage net installation.

After the surface on which the composite drainage net is to be installed has been accepted by the construction general contractor, the CQA representative will have responsibility to indicate to the CQA certifying engineer any change in the underlying layer that may, in accordance with the technical specifications, require repair work. If the CQA certifying engineer requires that repair work be done, it will be the responsibility of the construction general contractor to repair the underlying layer.

The CQA representative will verify and document compliance with the following:

- Just prior to composite drainage net placement, the layer that will underlie the composite drainage net is clean and free of excessive amounts of dust, dirt, stones, rocks, or other obstructions that could potentially damage the underlying layers or clog the drainage system.
- In the presence of excessive wind, the composite drainage net is weighted with sandbags (or equivalent weight approved by the CQA certifying engineer).
- Composite drainage net is kept under tension to minimize the presence of wrinkles in the composite drainage net. If necessary, the composite drainage net is positioned by hand after being unrolled, to minimize wrinkles.
- Composite drainage net is cut using a composite drainage net cutter, approved by the composite drainage net manufacturer and the CQA representative. If in place, special care is taken to protect other materials from damage that could be caused by the cutting of the composite drainage net.
- The construction general contractor takes all necessary precautions to prevent damage to the underlying layers during placement of the composite drainage net.
- Composite drainage net is not welded to geomembranes.
- During placement of clean composite drainage net, care is taken not to entrap stones, excessive dust, or moisture that could damage the underlying geomembrane, generate clogging of drains or filters, or hamper subsequent seaming.
- A visual examination of the composite drainage net is carried out over the entire surface, after installation, to ensure that no potentially harmful foreign objects, such as needles, are present.

- Composite drainage net is not left exposed for an excess of 14 days after placement, to prevent damage from exposure to ultraviolet radiation (sunlight).

The CQA representative will document any noncompliance with the above requirements and report it to the CQA certifying engineer.

6.1.7 Seams and Overlaps

The components of the composite drainage net (e.g., geotextile-geonet-geotextile) are not bonded together at the ends and edges of the rolls. The CQA representative will document that the composite drainage net is overlapped and secured in accordance with the technical specifications.

6.1.8 Repair

The CQA representative will verify that any holes or tears in the composite drainage net are repaired, in accordance with the technical specifications. The CQA representative will observe any repair, document any noncompliance with the above requirements, and report the noncompliance to the CQA certifying engineer. Repair areas will be documented using NCR procedures, outlined in Section 8.1.4.

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SECTION VII–POLYETHYLENE PIPE AND FITTINGS CONSTRUCTION QUALITY ASSURANCE

7.1 PIPE AND FITTINGS

The CQA representative will monitor the placement of the LCRS, LDS and SLDS pipe, located on the IDF landfill floor and on the landfill slopes.

7.1.1 Labeling

The CQA representative will verify that the pipe is labeled with the information specified in the technical specifications. Any deviations from the labeling requirements will be reported to the CQA certifying engineer prior to pipe installation.

7.1.2 Transportation and Handling

The CQA representative will verify and document that the pipe and fittings are handled in accordance with the technical specifications. The CQA representative will visually inspect the pipe upon delivery at the site, and any deviations from the requirements of the technical specifications will be reported to the CQA certifying engineer.

7.1.3 Storage

The CQA representative will verify and document that storage of the pipe and fittings is in accordance with the technical specifications.

7.1.4 Inventory

The CQA representative will inventory the polyethylene piping and fitting, delivered to the site that will be installed at the bottom and on the slopes of the landfill. The CQA representative will perform the following tasks:

- Verify the material for conformance with the technical specifications and construction drawings
- Verify slot dimensions for conformance with the technical specifications
- Check the material for damage, mishandling, and adverse exposure

Items that are restricted from further use until the inspections have been completed will be clearly delineated by the CQA representative. Accepted materials will be kept separate from inventoried and approved items, to the extent possible. The CQA representative will be responsible for coordinating with the construction general contractor during material delivery, to limit the material being moved more than necessary after it is unloaded and thereby minimizing damage due to handling.

The CQA representative will perform the inventory immediately after the material arrives onsite to avoid delaying construction. The CQA representative will be responsible for verifying that only accepted material is installed at the IDF landfill, and that all inventories and inspections are documented and maintained.

7.1.5 Conformance Testing

No conformance testing will be conducted on the materials delivered to the site.

7.1.6 Handling and Laying

The CQA representative will verify and document that the pipe is installed at the specified locations, grades, and angles, and that placement of backfill around and over the pipe is conducted in accordance with the requirements of the technical specifications and in a manner intended to prevent damage to the pipe.

The pipe and fittings will be carefully examined before installation by the CQA representative. The CQA representative will verify and document that cracks, damage, or defects are not present in the pipe and fittings in excess of that allowed by the technical specifications.

The CQA representative will also note the condition of the interior of pipes and fittings. Foreign material will be removed from the pipe interior before it is moved into final position. No pipe will be permitted to be placed until the CQA representative has observed the condition of the pipe. The CQA representative will document any deviation from the requirements and report it to the CQA certifying engineer.

7.1.7 Joints and Connections

Lengths of pipe will be required to be assembled into suitable installation lengths by the butt-fusion process. Butt-fusion refers to the butt-joining of the pipe by softening the aligned faces of the pipe ends in a suitable apparatus and pressing them together under controlled pressure. The CQA representative will spot-monitor butt-fusion welding operations to ensure that the construction general contractor follows the technical specifications for both slotted and solid pipes. The CQA representative will verify that internal weld beads have been removed from the horizontal and side slope sections of the LCRS, LDS, and SLDS riser pipes. The CQA representative will document any noncompliance with the requirements and report it to the CQA certifying engineer.

7.1.8 Surveying

A survey will be performed by or under the direction of a professional land surveyor registered in the State of Washington. The surveyor will independently survey the final elevation and alignment of the top of the pipe and fittings. Surveys will be performed on all pipe locations within the footprint of the landfill to confirm that the alignment and elevations in the field agree with those shown in the construction drawings. The results of the survey will be compiled in a report signed by the surveyor and the CQA certifying engineer.

The surveyor will be required to survey each pipe location within the IDF landfill, in accordance with the requirements of this CQA Plan. A record drawing will be submitted to the CQA certifying engineer by the surveyor before placement of the next liner system layer. The surveys will be conducted every 50 feet along the pipe alignment and appurtenances. The survey will include enough information to confirm that the following features of the landfill piping are constructed in accordance with the construction drawings:

- Beginning and end top of pipe elevations
- Connection location
- Grade breaks
- Riser pipes
- Sump extensions

The piping that will be surveyed will include, but not be limited to, the following:

- SLDS piping
- LDS piping
- LCRS piping

The CQA certifying engineer will approve the survey results for each layer before the subsequent component of the lining system is constructed.

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SECTION VIII–CONSTRUCTION QUALITY ASSURANCE DOCUMENTATION AND CERTIFICATION

8.1 DOCUMENTATION AND CERTIFICATION

A major function of CQA is to properly and adequately document and certify the work. This section describes the minimum required documentation. The CQA certifying engineer may recommend to the IDF CM additional documentation for performing CQA tasks that are for certification. In addition, the CQA certifying engineer will prepare forms, field data sheets, sample labeling schemes, and chain-of-custody procedures and submit them to the IDF CM and IDF PM for approval, prior to construction.

8.1.1 Daily Reports

Daily reports will be completed by the CQA representatives when they are onsite. All CQA personnel will be assigned field books by the CQA certifying engineer that will be labeled with a unique number. The CQA representatives, including the CQA certifying engineer, will record all field observations and the results of field tests in their assigned field book. When not in use, all field books will be left in the field records file. After each book is filled (or at the end of the project), the field book will be returned to the CQA certifying engineer and routed to the project files.

Each page of the field book will be numbered, dated, and initialed by CQA personnel. At the start of a new work shift, CQA personnel will list the following information at the top of the page:

- Job name
- Job number
- Date
- Name
- Weather conditions
- Page number (if pages are not pre-numbered)

The remaining individual entries will be prefaced by an indication of the time at which they occurred. If the results of test data are being recorded on separate sheets, it will be noted in the field book. Entries in the field book will include, but not be limited to, the following information:

- Reports on any meetings held and their results
- Equipment and personnel being used in each location, including construction general contractors

- Descriptions of areas being observed and documented
- Descriptions of materials delivered to the site, including any quality verification (vendor certification) documentation
- Descriptions of materials incorporated into construction
- Calibrations, or recalibrations, of test equipment, including actions taken as a result of recalibration
- Decisions made regarding use of material and/or corrective actions to be taken in instances of substandard quality
- Unique identifying sheet numbers of inspection data sheets and/or problem reporting and corrective measures reports used to substantiate the decisions described in the preceding item

At the end of each day, the field CQA monitor will summarize the day's activities on a daily field monitoring report form. The field report will include a brief summary of the day's activities and highlight any unresolved issues that must be addressed by the CQA certifying engineer or by CQA representatives the following day.

The daily field monitoring report will be filled out in triplicate. The CQA monitor will attach three copies of the field book notes for that day. The three copies will be distributed as follows:

- Original will be filed in field office
- One copy will be transmitted to the CQA certifying engineer
- One copy will be transmitted to the IDF CM

The CQA certifying engineer will review and initial each summary field report before distributing to the project quality records and the IDF CM.

8.1.2 Inspection Data Sheets

All observed field and laboratory test data will be recorded on an inspection data sheet. At a minimum, each inspection data sheet will include the following information:

- Unique identifying sheet number for cross-referencing and document control
- Description of the inspection activity
- If appropriate, location of inspection activity or location from which the sample was obtained
- Type of inspection activity and/or procedure used (reference to standard method when appropriate)
- Any recorded observation or test data, with all necessary calculations
- Results of the inspection activity and comparison with specification requirements
- Identification of any personnel involved in the inspection activity

- Signature of the individual(s) performing the CQA representative activity and concurrence by the CQA certifying engineer
- Identification of deficiencies and any required reinspections

Forms used for the data sheets will be prepared and submitted to the IDF CM and IDF PM in accordance with this section. The data sheets will include, but are not limited to, the forms listed below:

- Sample log
- Compaction test result log
- Soil test result summary form
- Equipment calibration log

8.1.3 Record Drawing Maintenance

The construction general contractor will maintain a complete set of construction drawings labeled "Red-Line" as-built drawings. At the completion of the project, the as-built drawings pertaining to the work certified under this CQA Plan will be produced in electronic format and submitted to the CQA certifying engineer. The CQA certifying engineer will review the completed set of as-built drawings and certify the drawing set as the record drawings for the IDF.

8.1.4 Non-Conformance Reporting

Deficiencies/defects identified by in-process testing may be reworked in accordance with the technical specifications or CQA Plan to correct the deficiency without initiating the NCR process (i.e., failed compaction test or failed geomembrane destructive test), and in-process tests will be tracked by the CQA representative until it is corrected. A non-conformance is considered to be a deficiency in characteristics, documentation, or procedures that renders the quality of an item or activity unacceptable or indeterminate. All deficiencies, defects, damage, or test failures that are not corrected by in-process rework will be considered a non-conformance and will be documented on a Non-Conformance Report (NCR) form. The non-conformance will be referred to the IDF CM, for disposition and initiation of corrective action processes.

All NCR situations will be brought to the attention of the IDF CM for concurrence, prior to initiating the NCR. Upon issuance of the non-conformance report, the IDF CM will notify the IDF design engineer, IDF quality engineer, and IDF PM that the report has issued. Other individuals, as directed by the IDF PM, will participate in NCR disposition, resolution, and corrective action processes as needed. All documentation relating to NCR situations will be retained in the project quality records.

8.1.5 Resolution of Contract Document Questions and Clarifications

Request for Information (RFI) forms will be provided to the CQA certifying engineer for the purpose of submitting written requests to the IDF CM, for assistance in understanding the design intent of the contract documents. The CM will determine whether the IDF design engineer's technical support staff will address the RFI.

RFIs initiated by the construction general contractor will be addressed by the IDF project engineer and CM, not by the CQA certifying engineer, and are not in the scope of the CQA Plan.

Any RFIs that result in contract document changes will be incorporated by the IDF CM and PM, following the procedures outlined in Section 8.1.6.

8.1.6 Construction Change Order and Contract Document Changes

Requests for changes to the technical specifications or construction drawings will be referred to the IDF CM and initiated as a change order. All change orders and resulting design changes will be approved by the appropriate project team member prior to implementation, as outlined in procedure HNF-IP-0842, Volume 4., Section 4.29 (Engineering Document Change Control Requirements). Requests for modifications to the CQA Plan will also be made by completing a change order to the IDF CM and procurement agent, with copies to the IDF quality engineer and IDF project engineer.

If, during the course of construction, questions arise regarding interpretation of the plans and/or specifications, the IDF CM will be contacted by the CQA certifying engineer. Any clarification of the construction drawings will be documented by a change order, if necessary, or by telephone conversation records or meeting minutes, and routed to the IDF design engineer, IDF CM, and IDF PM. The change order will also be routed to the project files.

8.1.7 Progress Reports

The CQA certifying engineer will prepare a summary progress report each week, or at time intervals established at the pre-construction meeting. At a minimum, this report will include the following information:

- A unique identifying sheet number for cross-referencing and document control
- The date, project name, location, and other information
- A summary of work activities accomplished during the progress reporting period
- Identification of areas or items inspected and/or tested during the reporting period that are addressed by the report
- A summary of the quality characteristics being evaluated, with appropriate cross-references to technical specifications and/or construction drawings
- References to the technical specifications or construction drawings defining the acceptance criteria for each inspected characteristic
- A summary of inspection and test results, failures, and re-tests
- A summary of construction situations, deficiencies, and/or defects occurring during the progress reporting period
- A summary of other problem resolutions and dispositions
- The signature of the CQA certifying engineer

The progress report will be submitted to the IDF PM no more than two days after the last reporting day in the progress report. Copies will also be submitted to the IDF PM, IDF quality engineer, and construction general contractor.

8.1.8 Final Documentation and Certification

All daily inspection summary reports, inspection sheets, problem identification and corrective measures reports, acceptance reports, change orders, NCRs, photographic records, progress reports, construction drawings, construction drawing revisions, and other pertinent documentation will be retained as permanent project quality records. At the completion of the project, a final CQA report that incorporates all such information, along with as-built drawings, will be prepared by the CQA certifying engineer and submitted to the IDF PM. The CQA certifying engineer will prepare an interim report for construction and testing of the test pads. A final CQA report and certification letter will be completed at the end of the construction that will fulfill the CQA certification requirements specified in WAC 173-303-335(4).

The CQA certifying engineer will coordinate the completion of the as-built record drawings that will be generated by a land surveyor licensed in the State of Washington. The as-built records will include scale drawings depicting depths, plan dimensions, elevations, fill thicknesses, and geosynthetic panel layouts. The report will include documentation of each construction component monitored by CQA personnel and will be signed, stamped, and certified by the CQA certifying engineer.

8.1.9 Storage of Records

During the construction of the IDF, the CQA certifying engineer will be responsible for all CQA documents. This includes the CQA certifying engineer's copy of the design criteria, plans, procedures, and specifications; the CQA Plan; and the originals of all the data sheets and reports. The field records will be kept in lockable, metal cabinets or on metal shelving within a facility, protected by a fire alarm and/or a communication system that provides fire department response and/or fire suppression systems; or, in an Underwriters Laboratory-listed, one-hour fire-rated cabinet. At the completion of the project, all completed documents will be routed to the project quality records.

8.1.10 Storage of Archive Construction Material Samples

The CQA certifying engineer will be responsible for storing construction material samples collected during the duration of the project.

The CQA certifying engineer will coordinate with the IDF PM and IDF CM on which samples will be archived at the completion of the project. All samples will be kept in small containers (i.e., 5-gallon plastic buckets). Each container will be labeled with the following information:

- Project name
- Date
- Sample I.D.
- Material type
- Point of contact

Control and protection of samples will be accomplished through the use of an index listing of samples. This index will identify each sample gathered and include the same information required for the sample containers. It will also identify where the sample is stored and person responsible for the sample storage, thus providing a documented record of each sample and methodology for verifying that all samples are available in storage and that no samples have been misplaced.

All samples will be stored neatly in a cool, dry location, approved by the CQA certifying engineer. The CQA certifying engineer will coordinate with the IDF PM and IDF CM to determine which sample will be archived at the project completion.

SECTION IX–REFERENCES

40 CFR 264.19. *Code of Federal Regulations*, Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities, Section 19, "Construction Quality Assurance Program." Office of the Federal Register. July 9, 1999.

ASTM. *1997 Annual Book of ASTM Standards*, Volume 4.08: Soil and Rock (I). American Society for Testing and Materials, Philadelphia, Pennsylvania. 1997.

CH2M HILL. *Drawings for the Integrated Disposal Facility (IDF) Detailed Design.* RPP-19941, Rev. 0. Prepared for CH2M HILL Hanford Group. February 2004.

CH2M HILL. *Specifications for the Integrated Disposal Facility (IDF) Detailed Design.* RPP-18489, Rev. 0. Prepared for CH2M HILL Hanford Group. February 2004.

Geosynthetic Research Institute (GRI). "Standard Test Method for Asperity Measurement of Textured Geomembranes Using a Depth Gage," Test Method GM12. Philadelphia, Pennsylvania. 2000.

U.S. Department of Energy. "Radioactive Waste Management," DOE O 435.1. August 28, 2001.

U.S. Environmental Protection Agency, Office of Research and Development. *Technical Guidance Document: Quality Assurance and Quality Control for Waste Containment Facilities*, EPA/600/R-93-182. Cincinnati, Ohio. 1993.

Washington Administrative Code (WAC) 173-303-335, *Construction Quality Assurance Program.*

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SECTION 15021--HIGH DENSITY POLYETHYLENE (HDPE) PIPE

PART 1--GENERAL

SUMMARY:

This section is for furnishing and installing leachate piping and associated components.

REFERENCES:

The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only. Recognizing some requirements of the references cited below may not be applicable, the Engineer shall judge the applicability of compliance with the references not specifically addressed herein. In the event of a conflict between the text of this Specification and the references cited herein, the text of this Specification shall take precedence or as directed by the Engineer.

ASTM INTERNATIONAL (ASTM)

ASTM D792	Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
ASTM D1248	Specification for Polyethylene Plastics Molding and Extrusion Materials.
ASTM D1505	Standard Test Method for Density of Plastics by the Density-Gradient Technique.
ASTM D2513	Specification for Thermoplastic Gas Pressure Pipe, Tubing, and Fittings.
ASTM D3350	Specification for Polyethylene Plastics Pipe and Fitting Materials.
ASTM F714	Standard Specification for Polyethylene Plastic Pipe (SDR-PR) Based on Outside Diameter.

CODE OF FEDERAL REGULATIONS (CFR)

49 CFR 192.285	Plastic pipe; qualifying persons to make joints.

DESCRIPTION:

Pipe: This section includes all high density polyethylene (HDPE) pipe used in the cells including but not limited to:

Leachate collection piping on floor and cleanout access pipes on the slopes of the trench.

Leachate discharge piping, leak detection piping, and associated riser pipes.

Double containment piping outside the cell (e.g., leachate force main and drain lines) and elsewhere as shown on the Drawings.

SUBMITTALS–APPROVAL REQUIRED:

See Section 01300, SUBMITTALS, for submittal procedures.

Manufacturer's certificates of compliance for all pipe and fittings. Certificates shall acknowledge that pipe and fittings meet the requirements of the Specifications.

Descriptive literature about the fusion equipment to be used and certification from the pipe supplier or manufacturer that the joining technician(s) is certified and experienced in heat fusion joining of HDPE pipe. Certification shall contain the following minimum information:

Name of technician.

Date of certification.

Statement by the pipe supplier that the technician is certified in the means and methods of joining the supplier's pipe and fittings using butt fusion techniques.

Make(s) and model(s) of fusion equipment the technician is certified to join pipe with.

SUBMITTALS–APPROVAL NOT REQUIRED:

Information/Record (IR):

Catalog and manufacturer's data sheets for HDPE pipe and fittings.

~~Descriptive literature about the fusion equipment to be used and certification from the pipe supplier or manufacturer that the joining technician(s) is certified and experienced in heat fusion joining of HDPE pipe. Certification shall contain the following minimum information:~~

~~Name of technician.~~

~~Date of certification.~~

~~Statement by the pipe supplier that the technician is certified in the means and methods of joining the supplier's pipe and fittings using butt fusion techniques.~~

~~Make(s) and model(s) of fusion equipment the technician is certified to join pipe with.~~

Catalog and manufacturer's data sheets, electrofusion couplers, mechanical cutters, and appurtenances.

PART 2--PRODUCTS

All HDPE pipe and fittings shall conform with additional applicable requirements defined in the Piping Schedule in Section 15060, PIPING-GENERAL.

HDPE PIPE:

Resin: HDPE pipe shall be manufactured from first quality extra-high molecular weight, high density polyethylene resin containing no more than 2 percent clean recycled polymer by weight. Resin shall meet or exceed the requirements of ASTM D3350 for PE3408 material with a cell classification of 345434C or higher. Alternate cell classifications are acceptable if one or more of the 6 numbers in the cell classification is greater than the minimum. Pipe shall be rated PE3408. Pipe and fittings shall be in compliance with schedule attached as supplement (see Attachment 1, HIGH DENSITY POLYETHYLENE (HDPE) PIPE) or as shown on the Drawings.

Quality: The pipe shall have uniform wall thickness and shall be uniform in color, opacity, density, and other physical properties. Pipe shall be homogeneous throughout and free of visible cracks, holes, blisters, bubbles, undispersed raw materials, or any contamination by foreign matter. Any pipe with nicks, scrapes, or gouges deeper than 10 percent of the nominal wall thickness shall be rejected.

Form: Pipe may be supplied in a continuous extruded seamless piece or in sections.

Manufacturer's Certificates of Compliance: The manufacturer shall submit a Certificate of Compliance of the HDPE pipe supplied for the IDF project, which will include that the pipe is grade PE3408 and the identity of the cell classification per ASTM D3350.

HDPE pipe SDR shall be as indicated on the Piping Schedule in Section 15060, PIPING-GENERAL.

Fittings: Fittings shall conform to the requirements of Article HDPE PIPE of this section, shall be compatible with components of the double containment system, and HDPE manholes where required.

Polyethylene fittings shall be from the same manufacturer as the pipe, molded or fabricated from polyethylene pipe and shall have the same or numerically smaller SDR than pipe connecting to the fitting. Fittings shall follow requirements in Attachment 1.

All reducing tees shall be factory molded if available as a standard item by any manufacturer having pipe meeting this section. If not available as a standard item, branch saddle reducing tees shall be used. Reducers shall be shop manufactured.

Fabricated branch connections will not be allowed if branch saddle connections are listed in the manufacturer's catalog.

All molded polyethylene fittings shall have the same or higher pressure rating as the pipe when installed in accordance with the latest technical specifications. All fabricated polyethylene fittings shall have the same or higher pressure rating as the adjoining pipe when installed in accordance with the manufacturer's recommendations.

DOUBLE CONTAINMENT PIPE:

Pipe Materials: Both carrier pipe and containment pipe shall meet the requirements of Article HDPE PIPE of this section.

Configuration: Double containment pipe shall consist of a carrier pipe installed within a containment pipe. All pipe and fittings shall provide an annular space between the carrier and containment pipes to accommodate possible flow of fluid from the carrier pipe.

Support Spacers: Support spacers shall be manufactured from nonmetallic, corrosion-resistant material with the same or better chemical compatibility properties as the HDPE pipe. Spacers shall be secured to the carrier pipe at maximum 8-foot intervals. Spacing shall be reduced if required to maintain the annulus between the carrier and containment pipes and shall be positioned to allow for unrestricted passage of possible flow of fluid from the carrier pipe. Spacers shall be chamfered at both ends to allow for removal of carrier pipe. Materials and systems used to secure the spacers to the pipe shall have the same or better chemical compatibility properties as the HDPE pipe.

Fittings: Fittings shall conform to the requirements of Article HDPE PIPE of this section and shall be compatible with components of the single wall HDPE pipe where required.

SLOTTED PIPE:

Leachate Collection Piping: Leachate collection and leak detection piping on the floor of the cells and elsewhere as shown on the Drawings shall be slotted. Cleanout access pipes and leachate transmission piping shall not be slotted.

In addition to meeting all other requirements of this section, slotted pipe shall have slots 0.128 inch wide and 1.25 inches long, in five places equidistant around the pipe. Slots shall provide a minimum of 9 square inches of open area per linear foot of pipe. Slotted pipes shall be free of cutting debris from the slot cutting process.

Perforated pipe with circular drill holes is not allowed.

PART 3--EXECUTION

GENERAL:

All HDPE pipe and fittings shall be installed in conformance with applicable code requirements referenced in Section 15060, PIPING-GENERAL.

DIMENSIONS:

Piping dimensions shown on the Drawings are approximate. It is the Construction General Contractor's responsibility to furnish and install piping of the proper dimensions, which will properly fit with the connecting elements, pipes, fittings, pumps, etc.

INSTALLATION:

Pipe shall be handled and stored in such a manner as to ensure a sound, undamaged condition.

Pipe shall be cut in a neat, workmanlike manner using a mechanical cutter that will not damage the pipe.

Joining of HDPE pipe to HDPE pipe shall be accomplished by thermal butt fusion joint; no solvent welding or adhesive welding shall be allowed. Electrofusion couplings shall only be allowed when access to piping is restricted and only as approved by the Engineer. Slotted leachate collection piping shall be joined with thermal butt fusion joints. Pipe shall be joined per ASTM D2657 and manufacturer's recommendations.

Single butt fusion welds shall be used to create pipe sections as long as practicable. Fabricated pipe sections and fittings may be joined by the double butt fusion process.

During installation, the pipe shall not be pulled across sharp projections that could cause gouges, kinks, or other types of damage. To minimize "snaking" due to thermal expansion, protect pipe from direct sunlight, or limit unrestrained length of pipe during installation.

Allowance for Thermal Expansion/Contraction:

HDPE has a coefficient of thermal expansion of 1.2 x 10-4 ft/ft/deg F. Buried HDPE pipe shall be installed with excess length between anchor points such that contraction caused by temperature drop to 40 degrees F will produce the length of pipe between two points shown on the Drawings. Amount of excess pipe depends on temperatures of pipe at the time of installation, according to Table 1 for buried piping:

TABLE 1

Installation Temperature (degrees F)	Excess Pipe Length (in./100 ft)
50	1.4
60	2.9
70	4.3
80	5.8
90	7.2
100	8.6
120	11.5

Installation temperature is of the pipe material and not ambient air temperature. Measure installation temperature with a strip thermometer laid directly on the pipe. Verify temperate and excess pipe length required immediately before burial.

Placement of Buried Pipes:

Excavate trench bottom and sides of ample dimensions to permit visual inspection and testing of entire flange, valve, or connection.

The pipe shall not be dropped into the trench. Exercise care when lowering pipe into trench to prevent twisting or damage to pipe. The full length of the pipe shall be firmly bedded on the trench bottom.

The pipe shall be bedded in such a way as to maintain grade with a tolerance of -0.0 percent, +0.5 percent with a uniform, constant grade and no localized low spots.

Pipe Base and Pipe Zone: As specified in Section 02320, TRENCH BACKFILL.

Keep trench dry until pipe laying and joining are completed.

Prevent foreign material from entering pipe during placement.

Close and block open end of last laid pipe section when placement operations are not in progress and at close of day's work.

Install closure sections and adapters for gravity piping at locations where pipe laying changes direction.

After joint has been made, check pipe alignment and grade.

Place sufficient pipe zone material to secure pipe from movement before next joint is installed.

Prevent uplift and floating of pipe prior to backfilling.

Place pipe along pipe runs starting at one end and moving towards the other to avoid joints that will not be feasible with butt fusion.

Tolerances:

Horizontal position of pipe centerline on alignment around curves maximum variation of 1.0 foot from position shown.

Pipe Cover: Minimum 2 feet 6 inches from finished elevation of overlying material, unless otherwise shown.

Temporarily close pipe ends as required to avoid introducing dirt or other foreign material into the pipe.

Trenching and backfilling operations shall be conducted in accordance with the requirements of Section 02320, TRENCH BACKFILL, for utility trenching. If trenching is used, underlying materials shall not be disturbed or damaged in anyway. Backfilling operations shall ensure that no voids are present under or at the sides of the pipe. Backfill shall initially be placed to the top of the pipe, then hand compacted. The remainder of the trench shall then be backfilled and compacted by hand or with a power tamper only.

On the floor of the cell, pipe may be placed directly on geosynthetic layers prior to placing drainage gravel. Placement of gravel around pipes shall be by hand unless otherwise approved by the Engineer. Placement operations shall ensure that no voids are present under or at the sides of the pipe. Placement operations shall not disturb the position of the pipe.

Where flanged joints are used, the bolts shall be evenly torqued using a crossing pattern to gradually tighten the lug nuts. Torque values shall be as recommended by the flange manufacturer. Flanged joints shall be retorqued after one hour or more has passed. Apply anti-seize compound on all threaded surfaces before tightening.

Flaws (minor imperfections, damaged areas, etc.) in HDPE pipe with a depth of 10 percent or less of the nominal wall thickness will not require repair or replacement. In double containment systems, carrier pipe with flaws deeper than 10 percent of the wall thickness shall be replaced. Single pipe or containment pipe with flaws between 10 and 25 percent of the wall thickness shall be repaired in accordance with the pipe manufacturer's recommendations. The Construction General Contractor shall certify in writing that the repaired area will have material properties that meet or exceed those of intact pipe. Any pipe with flaws deeper than 25 percent of the nominal wall thickness shall be rejected.

All valves and equipment shall be supported independently from pipe. Anchor valves such that turning moment resulting from their operation will not be transmitted to pipe.

Special Precautions at Flanges: Polyethylene pipe connected to heavy fittings, manholes, and rigid structures shall be supported in such a manner that no subsequent relative movement between polyethylene pipe at flanged joint and rigid structures is possible.

Butt-fusion shall be performed in accordance with pipe manufacturer's recommendations as to equipment and technique.

Weld Beads: Remove internal weld beads from the side slope risers and horizontal sections of slotted pipe where the LCRS and LDS pumps will be placed and the horizontal and vertical sections of the LCRS level transducer pipe and SLDS pipe. Remove all plastic debris from inside pipe.

Slotted Pipe. Slotted pipe shall be cut and joined so that full contact is made around the entire circumference of the weld. Partial weld contact because of joints through a slot row is not acceptable.

LOCATOR RIBBON:

Locator ribbon shall be installed as specified in Section 02320, TRENCH BACKFILL.

IDENTIFICATION RIBBON:

Underground pipelines, except for pipelines inside the Phase I liner limits, shall be identified by use of a plastic ribbon or stencil no less than 3 inches in width with a message printed on the ribbon which identifies the actual pipeline contents. Marking tapes or stencils shall be placed on existing lines where they are exposed by trenching operations. The ribbon shall be wrapped around the pipeline at no less than 1 wrap per 3 feet of run. The plastic ribbon/ stencil shall be color coded in accordance with the Piping Schedule.

CLEANING:

Clean all piping as required in Section 15060, PIPING-GENERAL, to remove all foreign materials including dirt, grease, and other matter.

CONSTRUCTION QUALITY CONTROL (ACCEPTANCE TESTING):

Per Section 15992, PIPING LEAKAGE TESTING, and the Piping Schedule in Section 15060, PIPING-GENERAL.

END OF SECTION 15021

ATTACHMENT 1
HIGH DENSITY POLYETHYLENE (HDPE) PIPE

Item	Size	Description
General	All	Pipe lengths, fittings, and flanged connections to be joined by thermal butt-fusion shall be of the same type, grade, and class of polyethylene compound and supplied from the same raw material supplier.
Pipe		Pipe SDR shall be AS INDICATED ON THE Piping Schedule in Section 15060, PIPING-GENERAL.
		Protection shall be provided against ultraviolet light degradation using carbon black, not less than 2 percent well dispersed in the resin.
		Pipe wall thickness shall reflect the required SDR* and diameter, as shown in Table 8, ASTM F714.
		Pressure rating shall be 100 psi minimum.
		*SDR: standard dimension ratio = OD/thickness
Fittings	6-inch and smaller	Molded fittings, butt fusion joined, conforming to ASTM D3261.
	8-inch and larger	Molded if manufactured as a standard item or same as pipe, butt fusion joined, conforming to ASTM D3350.
Electrofusion Couplers		Rigid, straight coupler constructed from injection-molded polyethylene with embedded heating coils as manufactured by Central Plastics; or equivalent.
Flanges		ASTM A351 Type 316/CF8M stainless steel, 150-pound, ANSI B16.5 standard, convoluted back-up ring with one-piece polyethylene molded flange adaptor ends, same rating pressure as pipe.
Bolting		Stainless steel, ASTM A193/A193M Grade B8M studs and ASTM A194/A194M Grade 8M hex head nuts.
		Manufacturer's recommended anti-seize compound on all threads.
		Washers shall be same material as bolts.
Gaskets		Flat ring, 1/8-inch Viton.

SECTION 02666--ADMIX LINER

PART 1--GENERAL

REFERENCES:

The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D698	Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbs/ft^3) (600 Kn-m/m^3)
ASTM D422	Method for Particle-Size Analysis of Soils
ASTM D2216	Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D6391	Standard Test Method for Field Measurement of Hydraulic Conductivity Limits of Porous Materials Using Two Stages of Infiltration from a Borehole

DESCRIPTION:

This section describes the low permeability admix that will be used in the liner of the disposal facility. In addition requirements for base soil in the evaporation pond lining system are specified.

The admix liner is an admixture that consists of natural base soil which is mixed with bentonite and moisture conditioned.

SUBMITTALS–APPROVAL REQUIRED:

See Section 01300, SUBMITTALS, for submittal procedures.

The Construction General Contractor shall submit a detailed plan for preparation of the admix material, including a description of the equipment and procedures to be used, personnel qualifications, and methods for monitoring bentonite additions and moisture conditioning. This plan shall be approved by the Engineer prior to the start of admix production.

The Construction General Contractor shall submit an admix liner placement plan to specify lift thickness control and to allow for required testing, specified herein and described in the CQA Plan, on the soil liner during placement operations. This plan shall be approved by the Engineer prior to the start of admix placement.

Supplier's descriptive data, specification sheets, literature, and other data as necessary to fully demonstrate that the bentonite proposed for use in the admix complies with the requirements of these Specifications. The manufacturer shall certify that the bentonite furnished complies with these Specifications. A certificate shall be submitted to the CQA Certifying Engineer for each railcar or every three truckloads of bentonite delivered.

Certificates for equipment calibration.

CONSTRUCTION QUALITY ASSURANCE:

Construction Quality Assurance testing will be provided by the CQA Certifying Engineer and shall be performed in accordance with the CQA Plan. The Construction General Contractor shall make allowances for sampling and testing by the CQA Certifying Engineer in both his production operations and schedule.

Prior to placing any materials over the completed admix liner, the Construction General Contractor shall allow time for acceptance of the Work as listed in the CQA Plan. The Construction General Contractor shall accommodate all CQA testing and sampling activities, as specified in the CQA Plan (i.e., in addition to the QC testing), and shall repair sample locations as specified herein.

DEFINITIONS:

Grain Size: Determined by ASTM D422.

Imported Material: Meets requirements of this Specification and is obtained offsite and transported to site.

Natural Moisture Content: Determined by ASTM D2216.

Optimum Moisture Content: Determined in accordance with ASTM D698 specified to determine maximum dry density for relative compaction.

Admix: Natural material (base soil), as specified in this section, that when mixed with bentonite.

Admix Liner: Compacted liner component consisting of admix materials, designed, formulated, and constructed to provide low-permeability barrier against infiltration of liquids or contaminants.

TOLERANCES:

Thickness of the admix liner shall be a minimum of 3 feet and tolerances for the top of admix grade shown on Phase I Primary Liner Plan shall be minus 0.1 foot to plus 0.3 foot. The minimum required thickness of the soil liner layer shall be maintained. The as-built elevations of the underlying prepared subgrade shall be used as the basis for determining the final elevation of the soil liner layer.

PART 2–PRODUCTS

BENTONITE:

The bentonite shall be Bara-Kade 90, manufactured by Bentonite Performance Materials, Inc.; or approved equal. Do not provide calcium bentonites or chemically treated sodium bentonites.

The bentonite to be used in the admix shall consist of a commercially prepared material and shall have the following index properties:

> High Swelling: Ability of 2 grams of base bentonite, when mechanically reduced to minus 100 mesh, to swell in water to an apparent volume of 20 cubic centimeters or more when added gradually to 100 cubic centimeters of distilled water contained in graduated cylinder.
>
> Dry Fineness: 65 percent minimum passing No. 200 U.S. Sieve.

The Construction General Contractor shall provide suitable containers on site to store bentonite in a dry condition prior to use.

BASE SOIL:

The base soil for the admix liner shall consist of natural soil derived from the admix base soil borrow area shown on the Drawings, as specified in Section 02317, BORROW AREA EXCAVATION, or from site excavations. Base soil from either source shall not be excavated below a depth of 5 feet below ground surface (after stripping) without evaluation of the material suitability and approval from the Engineer. This material may be temporarily stockpiled at the stockpile area as shown on the Drawings, or within processing area within Phase I as approved by the Construction Manager.

Base soil excavated from dune sand borrow area or site excavation shall meet the following requirements: The base soil shall be free of roots, woody vegetation, frozen material, rubbish, and other deleterious material. Rocks greater than 1 inch in dimension shall not comprise more than 2 percent by weight of the base soil. Base soil shall have 20 percent minimum passing No. 200 U.S. Sieve. Base soil shall be screened or otherwise processed if necessary to meet this requirement.

For evaluating compliance with these requirements, test results shall be considered acceptable when the average value of the data satisfies the associated criterion. Testing and sampling frequency for base soil compliance is provided in the CQA Plan.

ADMIX LINER MATERIAL (ADMIX):

Composition: The admix shall consist of the base soil mixed with a nominal bentonite content of 12 percent by dry weight of base soil by dry weight. The acceptable range for bentonite content shall be a minimum of 11 percent and maximum of 14 percent of base soil by dry weight. The bentonite percentage and moisture content range may change as a result of preconstruction testing performed on the test pad as described in the CQA Plan, and may be modified by the Construction General Contractor with the approval of the Construction Manager, Engineer, and the CQA Certifying Engineer at any time during the admix processing to reflect changes in the base soil or other components. The moisture content and bentonite dispersion in the admix shall be uniform and homogenous. The finished admix shall be a uniform homogenous material.

CQA Testing: The admix shall be prepared by the Construction General Contractor and tested by the CQA Certifying Engineer in accordance with the CQA Plan. The Construction General Contractor shall make the admix stockpiles available to the CQA Certifying Engineer at all times for sampling, testing, or visual observation.

Raw Water Supply: See Section 02200, SITE PREPARATION, and the Drawings for information on raw water supply availability and requirements for admix processing and admix liner placement and compaction.

PART 3--EXECUTION

ADMIX PROCESSING:

Bentonite Use Monitoring: Record weight of bentonite used and volume of admix produced each day.

Processing Using Pugmill:

The Construction General Contractor shall process and condition admix material using a central type pugmill plant prior to compaction. The pugmill shall have automated controls to continuously control the established proportions of bentonite and water as ratios of the base soil. It shall have provisions to easily change the proportions. It shall be capable of maintaining a constant time of mixing and varying the rate of discharge so that the degree of mixing can be controlled if necessary to achieve complete mixing.

The Construction General Contractor shall provide all necessary equipment and labor to operate the pugmill, load material into pugmill, offload admix, and stockpile admix.

Equipment: Admix shall be prepared using a pugmill with the following characteristics and ancillary equipment:

Continuous mixing pugmill. Blades shall be adjustable for angular position on shafts and shall be reversible to retard flow of mix.

Belt scales on base soil, bentonite, and finished product belts.

Feed rate meters and totalizers for bentonite, base soil, and water.

Production rate meters and totalizers for finished product.

Variable speed hydraulic supply water pumps capable of producing 500 tons per hour of admixture.

Calibration:

After setting up the pugmill, it shall be calibrated to determine the accuracy of the feed rate for each material being mixed. When the feed controls are set at any desired rate, the measured accuracy shall be within 1 percent by weight of the indicated feed rate for the item being mixed. The accuracy will be determined by operating each feed control separately and collecting and weighing the material over a given period of time as determined by the CQA Certifying Engineer. The material shall be collected in a dump truck (or appropriate container) supplied by the Construction General Contractor, and the truck will be weighed by the Construction General Contractor and verified by the CQA Certifying Engineer before and after loading. During admix production, the CQA Certifying Engineer may request a recalibration of the feed rate for each material as described above.

All measuring equipment shall be calibrated and calibration certificates provided to the CQA Certifying Engineer prior to starting admix production.

Preparation Requirements:

The base soil shall be processed through a pugmill to add bentonite at the specified rate, to add additional water if required, and to provide mechanical mixing action required to homogeneously blend the bentonite and water into the mix. Additional mixing by rotovator or other approved means shall be performed at the Construction General Contractor's sole expense as required to further break down the soil clumps or if additional mixing is needed to achieve a homogenous blend of soil, water, and bentonite. The admix shall be broken down in size sufficiently to result in at least 80 percent of the soil clumps broken down to 1/2 inch in maximum size. Clods are defined as dry hard particles in the admix that cannot be remolded by hand pressure.

If mixing is found to be insufficient to produce a thoroughly blended, uniform mixture of base soil and bentonite, or the base soil and bentonite are not being mixed in the specified proportions, the Construction General Contractor shall stop production of admix material. The Construction General Contractor shall not restart production and installation of admix liner until procedures and equipment have been modified so that the specified material is produced. Admix liner that is installed without complete mixing or the correct percentage of bentonite shall be removed and modified by the Construction General Contractor to meet the

Specifications. After being modified to meet the Specifications, the material may be reinstalled in the lining. Additional work and delays caused by inadequate or incorrect mixing shall be performed at the Construction General Contractor's sole expense. The Construction General Contractor shall not change the bentonite application rate unless directed to do so by the Engineer in writing.

Admix shall be processed and allowed to cure at least 12 hours prior to placement. The Construction General Contractor shall be responsible for maintaining the moisture content of the admix within the specified limits. Admix that does not meet Specifications shall not be reused as feed stock unless approved by the Engineer and CQA Certifying Engineer.

TEST PAD(S):

Test pads for the admix liner shall be constructed as specified in Article ADMIX LINER PLACEMENT AND COMPACTION, by the Construction General Contractor to determine acceptable placement and compaction methods to produce a low-permeability admix liner that satisfies the requirements of this section. Both a horizontal and sideslope test pad shall be constructed. The location of the test pads will be designated by the Construction Manager and the CQA Certifying Engineer.

Test Pad Material: The Construction General Contractor will prepare a sufficient quantity of soil for the test pad in accordance with the requirements of Article ADMIX LINER MATERIAL. All specified procedures for mixing, conditioning, and stockpiling of the soil material will be followed.

Horizontal Test Pad Construction:

The test pad will be constructed on a horizontal surface within the limits of the IDF in an area representative of conditions beneath the waste disposal cells. The pad will be located in a well-drained area to prevent surface water intrusion or saturation of the test pad soils. The test pad location will be cleared and grubbed, and the subgrade will be compacted in the same manner anticipated for construction beneath the waste disposal cells. Prior to placement of the test pad materials, the Contractor's Site Superintendent and the CQA Certifying Engineer will evaluate the condition of the subgrade; areas containing potentially unsuitable materials will be replaced, or another location will be selected for the test pad.

So that the test pad will accurately represent the performance of the full-scale facility, the following guidelines will be followed:

Construction of the test pad will use the same soil materials, design specifications, equipment, and procedures as proposed for the full-scale facility.

The test pad will be constructed at least four times wider than the construction compactor drum width to be used for the full-scale facility and allow for installation of field permeability testing per method ASTM D6391 or 50 feet minimum (whichever is greater). This is required to ensure a sufficient representative area for testing, avoiding the edges of the test pad. The test pad may be subdivided into "lanes" to facilitate evaluation of different compaction methods; however, the width of any individual lane shall be no less than twice the width of the construction compactor drum equipment.

The test pad will be long enough to allow construction equipment to achieve normal operating speed before reaching the area that will be used for testing or 80 feet minimum (whichever is greater).

The test pad will be constructed with at least six lifts to evaluate the methodology used to tie lifts together. Lift thickness will be as described in Article ADMIX PLACEMENT AND COMPACTION, and the total thickness of the test pad will be at least 3 feet.

The test pad constructed will include the removal and replacement of a portion of the soil to evaluate the method proposed for repairing defective portions of the full-scale liner as specified in Article REPAIR OF ADMIX LINER.

<u>Sideslope Test Pad Construction:</u>

The sideslope test pad will be constructed on a 3H:1V sideslope (within the lined area of Phase I) to evaluate compaction methods and performance on the sideslope. Field permeability testing is not required for sideslope test pad. Sideslope test pad will be used to demonstrate that compaction and placement methods to achieve acceptable moisture and density requirements can be achieved.

So that the test pad will accurately represent the performance of the full-scale facility, the following guidelines will be followed:

Construction of the test pad will use the same soil materials, design specifications, equipment, and procedures as proposed for the full-scale facility.

The test pad will be constructed at least four times wider than the widest piece of construction equipment to be used for the full-scale facility or 40 feet minimum (whichever is greater). This is required to ensure a sufficient representative area for testing, avoiding the edges of the test pad. The test pad may be subdivided into "lanes" to facilitate evaluation of different compaction methods; however, the width of any individual lane shall be no less than twice the width of the widest piece of construction equipment.

The test pad will be long enough to allow construction equipment to achieve normal operating speed before reaching the area that will be used for testing or 80 feet minimum (whichever is greater).

The test pad will be constructed with at least six lifts to evaluate the methodology used to tie lifts together. Lift thickness will be as described in Article SOIL BENTONITE PLACEMENT AND COMPACTION, and the total thickness of the test pad will be at least 3 feet.

<u>Demonstrate the Following During Test Pad(s) Construction:</u>

Base soil/bentonite mixing process prior to compaction.

Compaction equipment type, configuration and weight.

The method used to break down clods before compaction and maximum resulting clod size.

The speed of compaction equipment travelling over the test pad.

Moisture content of soil bentonite at time of compaction.

Lift thicknesses (compacted), compaction procedures, and number of passes for proposed compaction equipment.

Dry unit weight achieved and measured by field density testing.

Hydraulic conductivity of compacted test fill on undisturbed samples (Shelby Tubes) as described in the Construction Quality Assurance (CQA) Plan.

Field permeability of compacted test fill using ASTM D6391 (horizontal test pad only) as described in the CQA Plan.

Excavate at least four holes, each 3 feet square, through each completed pad for observation, sampling, and testing of compacted material. These holes shall be used for the purpose of demonstrating repair methods as specified herein.

No admix liner shall be placed until the associated test pad has been constructed and the results from all test methods indicate that the admix liner will satisfy the permeability requirements specified in this section. Testing for each test pad shall be as described in the CQA Plan. At the completion of the test pad(s), the CQA Certifying Engineer, as described in the CQA Plan, will prepare an interim report with recommendations for compaction and placement methods to be applied to the full-scale admix liner construction.

After all testing has been completed and approved, the material in the test pad can be used by the Construction General Contractor for liner construction provided that the material satisfies the requirements of these Specifications.

SUBGRADE PREPARATION:

As specified in Section 02319, SUBGRADE PREPARATION, Article PREPARED SUBGRADE FOR ADMIX LINER.

ADMIX LINER PLACEMENT AND COMPACTION:

Lift Thickness: Admix liner material, as specified in Article ADMIX LINER MATERIAL, shall be placed in loose lifts and compacted such that the compacted lift thickness is 6 inches or less. However, the first lift of admix liner placed over subgrade soils may be placed and compacted to a maximum thickness of 8 inches.

Placement methods shall prevent excessive mixing of admix liner with subgrade soil.

Compaction: The intent of this Specification is that admix liner shall be produced to meet an in-place performance specification of less than $1x10^{-7}$ cm/sec hydraulic conductivity within the limits of edge of liner shown on the Drawings. See paragraph Outside Edge of Liner in this Article for compaction and hydraulic conductivity requirements beyond edge of liner. The Construction General Contractor is responsible to develop and use compaction methods that produce the required relative compaction.

The moisture-density range of the compacted admix shall lie within a trapezoidal-shaped field with the following corners:

Moisture Content (%)	Dry Density (pcf)
8	126
12	110
14	126
19	110

Hydraulic Conductivity: The in-place compacted admix liner shall achieve a saturated hydraulic conductivity as listed below:

All field (in-situ) test results shall be 1×10^{-7} cm/sec or less. Field (in-situ) hydraulic conductivity tests will be performed only on admix liner of the horizontal test pad.

All hydraulic conductivity during admix production placement will be verified on undisturbed Shelby tube samples (see ASTM D1587) obtained from in-place admix liner per the CQA plan and then tested in laboratory using methods as described in ASTM D5084.

Hydraulic conductivity will be verified on undisturbed samples from completed areas of the liner as described in the CQA Plan. The arithmetic average of laboratory test results on undisturbed samples shall be 2.5×10^{-8} cm/sec, with no individual test result exceeding 5×10^{-8} cm/sec. The acceptable values for laboratory test results will be verified or adjusted prior to admix liner production placement based on the correlation of field and laboratory hydraulic conductivity test results from the horizontal test pad. The final laboratory hydraulic conductivity requirement will be approved by the CQA Certifying Engineer and documented in the horizontal test pad report.

Outside Edge of Liner: Admix liner shall be placed in maximum 6-inch compacted lift thickness. Compact admix liner to minimum 92 percent relative compaction from optimum moisture content to 4 percent wet of optimum. Performance specification for admix hydraulic conductivity do not apply to admix placed beyond edge of liner.

Uniformity: The compacted soil distribution and gradation throughout the liner shall be free from lenses, pockets, streaks, layers, or material differing substantially in texture, moisture content, dry density, or gradation from surrounding material. The admix liner material shall be free of organic debris, frozen material, rubbish, construction debris, and other deleterious material. Any soil containing unacceptable material shall be removed and discarded in the permanent stockpile, placed in accordance with Section 02315, FILL AND BACKFILL.

Moisture Conditioning: The moisture content of the admix liner shall be uniform throughout each lift prior to and during compaction of the material. If the moisture content of a lift of compacted admix liner falls below the acceptable limit during placement operations, the Construction General Contractor shall moisture condition the dry soil and re-compact the lift prior to placement of additional lifts. If the moisture content of a lift of compacted soil exceeds the acceptable limit due to precipitation or over watering, the Construction General Contractor, before placement of additional lifts, shall either allow the wet soil to dry back or remove the wet soil. If the admix liner material cannot be conditioned to meet the placement specifications, the material shall be removed and replaced with new admix liner.

When the final lift of admix liner placement will be interrupted for more than a few hours or when precipitation is imminent, as determined by the Contractor's Site Superintendent, the lift surface shall be sealed with a smooth drum roller to prevent excessive moisture infiltration. This surface shall be scarified with a rotovator, or other equivalent equipment, immediately prior to resuming soil placement. The Construction General Contractor shall verify that existing moisture content is within the range specified in Article ADMIX LINER PLACEMENT AND COMPACTION, prior to resumption of soil placement activities.

Placement Equipment: The Construction General Contractor shall place layers of the admix liner to form a continuous monolithic material. All admix liner shall be placed and compacted with a self-propelled pegfoot or padfoot roller compactor having a minimum operating weight of 68,000 pounds. Smaller compaction equipment may be used in limited areas as necessary provided that the required moisture/density, lift bonding and hydraulic conductivity can be achieved. Hydraulic conductivity performance specification for the admix liner will be verified in areas where the lighter equipment is used. Hauling and spreading equipment will not be considered as compaction equipment. The compactor feet shall be sufficiently long to knead (bond) new lifts into previously placed lifts. The feet shall be kept free of large amounts of dried soil that might restrict foot penetration or become incorporated into the soil lift. The top of each lift may be scarified with a rotovator, or other equivalent equipment or procedures, prior to placing the subsequent lift. The final lift of admix liner may be compacted with a smooth drum roller provided that all other requirements are met.

Provide a smooth soil surface on the final lift prior to placement of the HDPE geomembrane as specified in Article SURFACE FINISHING.

Tie-in Areas: Where new admix liner is tied in to existing admix of a previous day's placement, any areas of the existing admix which are soft, cracked, or otherwise unsuitable shall be removed until acceptable material is exposed. Where new admix will be placed, the surface of the existing admix liner shall be scarified and moisture conditioned as described in this section. New admix liner shall be placed in accordance with the requirements of this section and shall be thoroughly kneaded into the existing admix liner to form a monolithic mass free of seams or other discontinuities.

Placement Method: Admix liner may be placed on the sideslopes in either horizontal lifts (along the contour) or in lifts parallel to the slope (up and down the slope). If admix liner is placed parallel to the slope, compaction equipment shall not spin their wheels or in any other way disturb the previously placed lifts. If this occurs, the Construction General Contractor shall place all of the admix liner in horizontal lifts.

Restrictions: Production, mixing, and stockpiling of admix or native clay soil shall be restricted to the area shown on the Drawings or within the Phase I footprint as approved by the Construction Manager.

SURFACE FINISHING:

The surface of the admix liner shall be trimmed to the design grades and tolerances as shown on the Drawings. The surface of the admix liner shall be rolled with a smooth-drum roller to remove all ridges and surface irregularities as specified in Section 02319, SUBGRADE PREPARATION. All wheel ruts in excess of depths specified in Section 02319, SUBGRADE PREPARATION, on the surface of the admix liner shall be repaired by the Construction General Contractor prior to placement of the geomembrane. Acceptable methods for repair of the admix liner are specified in Article REPAIR OF ADMIX LINER.

MAINTENANCE:

The Construction General Contractor shall maintain the admix liner surface in a condition suitable for geomembrane installation until the surface is covered. The admix liner shall be protected from desiccation or excessive moisture. This may be accomplished by periodic watering, exclusion of traffic, placement of a temporary removable plastic cover, or other methods. Desiccation cracks larger than 1 inch deep or 0.25 inch wide shall be excavated to the full depth of the crack and repaired as specified in Article REPAIR OF ADMIX LINER. In the event that the geomembrane cannot be installed within 12 hours after placement of the final admix liner lift, the final lift of admix liner shall be constructed 4 to 6 inches thicker than required and cut to finish grade immediately before geomembrane deployment.

The Construction General Contractor shall take measures to prevent the admix liner from freezing. Lifts of admix liner shall not be placed on frozen surfaces. Geomembrane shall not be placed on a surface which is frozen or has been frozen and thawed until directed by the Construction Manager and the CQA Certifying Engineer.

REPAIR OF ADMIX LINER:

The Construction General Contractor shall repair the surface of any areas identified to be out of tolerance. The size of the repair area shall be as required to remove and/or repair defective areas of the admix liner. Repair as follows:

Remove soil that does not meet specifications.

Scarify surface and spray with water.

Place additional approved admix material.

Compact soil with self-propelled pegfoot or padfoot type compactor as described above.

Trim and roll the surface as described above to design grades and tolerances.

Alternative methods for repair of the admix liner will be allowed if submitted by the Construction General Contractor and approved by the Engineer and Construction Manager.

Construction General Contractor will repair small holes (up to a maximum 6-inch diameter) resulting from sampling and other CQA activities. Such holes shall be repaired by backfilling with admix liner or powdered bentonite material in lifts of no more than 2-inch thickness and hand tamping with a steel rod or other suitable device to firmly compact each lift.

CONSTRUCTION QUALITY ~~CONTROL~~ ASSURANCE AND ACCEPTANCE:

Testing and criteria for admix liner acceptance is provided in the CQA Plan, which is made part of these Specifications by reference.

END OF SECTION 02666

SECTION 02667--GEOSYNTHETIC CLAY LINER (GCL)

PART 1--GENERAL

REFERENCES:

The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D4632	Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
ASTM D4643	Standard Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method
ASTM D4833	Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products
ASTM D5084	Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter
ASTM D5887	Standard Test Method for Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter
ASTM D5890	Standard Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liner
ASTM D5891	Standard Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners
ASTM D5993	Standard Test Method for Measuring Mass Per Unit of Geosynthetic Clay Liners

DESCRIPTION:

The Work includes supply and installation of geosynthetic clay liners (GCLs) for the landfill lining system as shown on the Drawings.

SUBMITTALS–APPROVAL REQUIRED:

See Section 01300, SUBMITTALS, for submittal procedures.

Submit manufacturer's descriptive data, specification sheets, literature, and other data as necessary to fully demonstrate that the materials proposed for use comply with the requirements of these Specifications.

Submit manufacturer's quality control test results, written properties certification guarantee, and QC certificates, as specified in PART 2--PRODUCTS.

CONSTRUCTION QUALITY ASSURANCE (CQA):

Quality assurance procedures are presented in the CQA Plan. CQA Plan requirements are discussed in Section 02661, GEOMEMBRANES. The Construction General Contractor shall accommodate all quality assurance activities described herein and in the Construction Quality Assurance Plan (CQA Plan) for this project.

Prior to placing any materials over the installed GCL, the Construction General Contractor shall allow time for acceptance of the Work as listed in the CQA Plan.

CQA CONFORMANCE TESTING:

Prior to deployment of the GCL, CQA personnel will remove samples and forward them to an approved geosynthetics laboratory for testing to document conformance to both the design specifications and the list of guaranteed properties. Unless otherwise specified, samples shall be taken at a rate of one per lot or one per 50,000 square feet, whichever results in the greater number of tests. Samples shall be taken from any portion of the roll that has not been damaged. Unless otherwise specified, samples shall be 3 feet long by the roll width. The machine direction shall be marked on the samples with an arrow.

As a minimum, the following tests shall be performed on GCL:

1. Bentonite Swell Index: ASTM D5890.

2. GCL Index Flux: ASTM D5887.

3. Bentonite Mass per Unit Area: ASTM D5993.

The CQA Certifying Engineer shall be allowed to remove samples of GCL for testing and other activities. Sample dimensions, procedures, and frequency shall be the same as those specified in the CQA Plan. The Construction General Contractor shall assist the CQA Certifying Engineer as necessary in all sampling and testing activities.

Procedures for samples that fail conformance testing are outlined in the CQA Plan. The cost of additional conformance testing to demonstrate compliance of failed samples shall be borne by the Construction General Contractor.

PART 2--PRODUCTS

GCL:

GCL shall be BENTOMAT(R) DN as manufactured by Colloid Environmental Technologies Co. (CETCO), Arlington Heights, IL; or Bentofix NWL as manufactured by GSE Lining Systems, Houston, TX; or approved equal, and shall meet the following requirements:

Property	Requirement	Test Method
Bentonite Mass/Area, lb/sq ft at 0% moisture content, MinARV	0.75	ASTM D5993
Bentonite Fluid Loss, mL, MaxARV	18	ASTM D5891
Bentonite Swell Index, mL/2g, MinARV	24	ASTM D5890
Grab Strength, lb, Tested Dry, MinARV	150	ASTM D4632
Peel Strength, lb, Tested Dry, MinARV	15	ASTM D4632
Index Flux, $m^3/m^2/sec$, MaxARV • 2 psi Water Head Pressure • 5 psi Effective Confining Pressure	$1x10^{-8}$	ASTM D5887
Permeability with Water, cm/sec, MaxARV • 2 psi Water Head Pressure • 5 psi Effective Confining Pressure	$5x10^{-9}$	ASTM D5084
Finished GCL Roll Width, Feet, MinARV	14	Linear Measurement
Finished GCL Roll Length, Feet, MinARV	150	Linear Measurement

The bentonite in the GCL shall be a sodium montmorillonite clay.

The GCL shall be manufactured so that the bentonite shall be continuously contained throughout the GCL and to support the geotextiles so that no displacement of the bentonite occurs when the material is unrolled, moved, cut, torn, or punctured. GCL products that utilize an alternate edge system with grooves cut in seam overlap areas are permitted subject to approval of the Engineer. Any adhesive used shall be inert, nontoxic, and water soluble. GCL materials made without the use of adhesives shall be stabilized to contain the granular bentonite by a process such as needle-punching or stitching through the top and bottom layers of geotextile and the bentonite.

Encapsulating geotextile materials shall be polypropylene, consisting of two nonwoven geotextile components which are needle-punched together. The nonwoven components of the GCL shall have a nominal mass per unit area of 6 ounces per square yard needle-punched geotextile.

Quality control testing shall be carried out by the manufacturer to demonstrate that the GCL meets the specifications in this section. Tests shall be conducted on each production lot of GCL or every 50,000 square feet, whichever results in the greater number of tests.

The manufacturer shall provide a written guarantee that the GCL has the properties listed on the specification sheet.

The GCL manufacturer shall provide a quality control certification that the GCL has the properties listed on the specification sheet for each roll of GCL shipped to the project site. The quality control certificate shall be signed by a responsible party employed by the manufacturer, such as the production manager. The quality control certificate shall include:

1. Roll numbers and production lot identification.

2. Results of manufacturer quality control tests.

3. Results of bentonite supplier quality control tests for bentonite used in GCL production.

ACCESSORY BENTONITE:

Accessory bentonite for seaming shall be as recommended by the GCL manufacturer.

TRANSPORTATION, HANDLING, AND STORAGE:

Transportation of the GCL shall be the responsibility of the manufacturer, and the Construction General Contractor. All handling on site shall be the responsibility of the Construction General Contractor.

Upon delivery at the site, the Construction General Contractor shall observe the surfaces of all rolls for defects and for damage. This inspection shall be conducted without unrolling rolls unless defects or damages are found or suspected. The Construction General Contractor will determine:

Rolls, or portions thereof, which should be rejected and removed from the site because they have severe flaws.

Rolls that are not properly labeled. No unlabelled rolls shall be used for any application. Unlabelled rolls shall be removed from the site and replaced at the Construction General Contractor's expense.

The Construction General Contractor shall be responsible for the storage of the GCL onsite. The Construction General Contractor shall provide storage space in a location as shown on the Drawings or as approved by the Construction Manager such that on-site transportation and handling are optimized to the extent possible. Storage space shall be protected from theft, vandalism, passage of vehicles, etc. Stored GCLs shall be protected from moisture and other damaging conditions in accordance with the manufacturer's recommendations.

PART 3--EXECUTION

GENERAL:

Install GCLs at the locations, lines, and grades shown on the Drawings. All GCLs shall be installed in accordance with these Specifications.

Materials and Work which fail to meet the requirements of these Specifications shall be removed and disposed of at the Construction General Contractor's expense. This includes GCL rolls that are not labeled or where the label has deteriorated to the point of being illegible.

HANDLING AND PLACEMENT:

The Construction General Contractor shall handle and deploy all GCLs in such a manner as to ensure that they are not damaged.

SURFACE PREPARATION—PRIMARY GCL:

For the IDF project, primary GCL will be deployed over the CDN surface. primary GCL shall be placed over a firm, unyielding surface. Wrinkle height in the underlying LDS CDN shall be minimized as to allow primary GCL deployment on a flat unyielding surface. Maximum wrinkle height for geosynthetics is specified in Section 02661, GEOMEMBRANES.

SURFACE PREPARATION – SECONDARY GCL:

As specified in Section 02319, SUBGRADE PREPARATION.

DEPLOYMENT:

GCL shall be deployed so that seams run up and down (not across) the slope.

Prior to placement of cover material over the GCL and HDPE geomembrane, the moisture content of the bentonite component of the GCL shall not exceed 100 percent. Only areas of GCL suspected of exposure to excessive moisture, in the judgement of the CQA Certifying Engineer, shall be sampled for moisture content. GCL panels with bentonite component moisture content greater than 100 percent shall be removed and replaced at Construction General Contractor's expense, regardless of the source of moisture, including adsorption from subgrade soil and/or condensation under the HDPE geomembrane or temporary plastic cover.

Any wrinkles in excess of the maximum wrinkle height specified in Section 02661, GEOMEMBRANES, shall be reduced to below specified height by adjusting and smoothing the GCL after placement.

GCL shall not be deployed during precipitation or in the presence of moisture, ponded water, snow, or in other situations that could cause premature hydration of the bentonite. Any GCL that hydrates prematurely shall be removed and replaced at the Construction General Contractor's expense.

The panels shall be placed to provide an overlap of 6 inches on longitudinal (edge of roll) seams, regardless of slope steepness. The panels shall be placed to provide an overlap of 24 inches on transverse (end of roll) seams for slopes flatter than 6H:1V. No transverse seams shall be allowed on slopes 6H:1V and steeper.

No more GCL shall be deployed than can be covered with geomembrane or other protective layer the same day.

Provide protection from wind uplift as necessary using sandbags or other method that will not damage the GCL.

OVERLAPPING GCL PANELS:

Overlap marks 6 inches from the panel edge shall be marked longitudinally on the GCL to assist in obtaining the proper overlap.

Prior to lapping, remove all dirt, gravel, or other debris from the overlap area. Apply 1/4 pound of accessory per linear foot of seam. Lap areas that have been contaminated by soil and/or sand shall receive additional accessory bentonite in the amount of 1/4 pound per linear foot evenly spread across the longitudinal seam area. GCL products with alternate edge treatment system with grooves cut in the seam overlap area, that eliminate the requirement for accessory bentonite, are permitted for edge of roll seams with prior approval by the Engineer. Accessory bentonite shall be required for end of roll seams.

End of roll overlap on slopes less than 6H:1V shall be shingled so that the direction of flow is from the top panel onto the bottom panel. On slopes 6H:1V and steeper, the panels shall be placed with the long dimension (length) continuous from the crest to the toe and the upper end anchored in a trench with soil backfill as shown on the Drawings.

REPAIRS:

Replace or repair damaged or hydrated areas of GCL.

Place a patch of GCL that extends at least 12 inches beyond the edges of the damaged area in all directions.

Overlap areas shall conform to requirements for seams described above.

PLACEMENT OF OVERLYING MATERIALS ON GEOSYNTHETIC CLAY LINING:

The GCL shall be completely covered with HDPE geomembrane or temporary plastic cover and protected at the end of each shift or workday. The Construction General Contractor shall be fully responsible to protect the GCL from damage, shrinkage, or prehydration and shall replace all affected materials at the Construction General Contractor's sole expense.

To prevent premature hydration or shrinkage in hot weather, only the amount of GCL that can be anchored, inspected, repaired, and covered with HDPE geomembrane or temporary plastic cover in the same day shall be installed.

Equipment used to install the overlying materials shall not operate directly on the GCL.

Construction General Contractor shall use a "rub sheet" of smooth HDPE geomembrane between the GCL and textured HDPE geomembrane to prevent damage to the GCL while maneuvering the textured HDPE geomembrane into position for seaming. Construction General Contractor shall develop method(s) of removing rub sheet that, after maneuvering textured HDPE geomembrane into place, prevents damage to toe underlying GCL.

Overlying materials shall be placed over the GCL and HDPE geomembrane as specified in Section 02661, GEOMEMBRANES.

END OF SECTION 02667

SECTION 02920--RECLAMATION AND REVEGETATION

PART 1--GENERAL

SUMMARY:

This section includes, but is not limited to, stabilization measures to prevent wind and water caused erosion of areas disturbed by the construction.

REFERENCES:

ASTM INTERNATIONAL (ASTM)

ASTM D586	Standard Test Method for Ash in Pulp, Paper, and Paper Products

SUBMITTALS–APPROVAL REQUIRED:

See Section 01300, SUBMITTALS, for procedures.

Manufacturer's technical data and installation recommendations for erosion control matting, including type and spacing of anchorage devices.

Manufacturer's written certification that wood fiber mulch product contains less than 250 parts per million boron, is nontoxic to plant and animal life, and satisfies the specified organic matter content as determined by ASTM D586.

SUBMITTALS–APPROVAL NOT REQUIRED:

Information/Record (IR):

Tackifier and Mulch: Submit manufacturer's information and/or product data sheets for the tackifier selected for use on this project. Include confirmation of the application rate which will be used. Submit Material Safety Data Sheets for the tackifier and any dye used in the tackifier and mulch application.

Installation warranty.

PART 2--PRODUCTS

MATERIALS:

Topsoil: Strippings that are free from toxic minerals, noxious weeds, and other objectionable material shall be used for topsoil in accordance with Section 02200, SITE PREPARATION. Vegetation shall be removed during clearing and grubbing in accordance with Section 02200, SITE PREPARATION. The removed vegetation, other than noxious weeds, shall be reduced to pieces that are no larger than 1 inch in any dimension and shall be incorporated uniformly into the strippings. Large clods, hard lumps, rocks 2 inches in diameter and larger, and litter shall be removed from the topsoil.

Topsoil shall be stockpiled in accordance with Section 02200, SITE PREPARATION.

Grass Seed: Grass seed shall be crested wheatgrass var. Nordan. The grass seed shall conform to the standards for "Certified" grade seed or better as outlined by the State of Washington Department of Agriculture "Rules for Seed Certification," latest edition.

Seed shall be furnished in standard containers on which shall be shown the following information:

Common name of seed.

Lot number.

Net weight.

Percentage of purity.

Percentage of germination.

Percentage of weed seed content and inert material clearly marked in accordance with applicable state and federal laws.

The maximum allowable noxious weed percentage (by weight) is 0.5 percent. The maximum allowable inert percentage is 7 percent.

Upon request, the Construction General Contractor shall furnish to the Construction Manager duplicate copies of a statement signed by the vendor certifying that each lot of seed has been tested by a recognized seed testing laboratory within 6 months before the date of delivery on the project. Seed which has become wet, moldy, or otherwise damaged in transit or storage will not be accepted.

Fertilizer: Fertilizer shall be either fertilizer Type A or fertilizer Type B.

Fertilizer Type A shall be an organic product developed from byproducts of the manufacture of various antibiotics, enzymes, and proteins. Fertilizer Type A shall provide a slow release of organically bound nutrients including nitrogen, potassium, and phosphorous. It shall have a minimum analysis (nutrient ratio) of 7-2-3 (nitrogen-phosphorous-potassium) with pH in the range of 5.3 to 6.0. Fertilizer Type A shall be sterilized and weed free. Fertilizer Type A shall be supplied in dried, granulated form with the dried weight, contents, and chemical analysis clearly marked on each bag. One suggested product name for fertilizer Type A is Biosol Mix, Rocky Mountain Bio-Products, Inc., Edwards, CO.

Fertilizer Type B shall be an organic product manufactured from seedmeal (60 percent), protein-derived, and fortified with calcium-rich (300 pounds per ton) composted chicken manure. Fertilizer Type B shall provide a slow release of organically bound nutrients including nitrogen, potassium, and phosphorous. It shall have a minimum analysis (nutrient ratio) of 6-4-1 (nitrogen-phosphorous-potassium) with pH in the range of 5.3 to 6.0. Fertilizer Type B shall be biodegradable, nonpolluting, nonvolatile, nontoxic, sterilized and weed free, and contain no heavy metals or salts. Fertilizer Type B shall be supplied in dried, pelletized form with the dried weight, contents, and chemical analysis clearly marked on each container. One suggested product name for fertilizer Type B is Fertile-Fibers Nutrimulch™, Quattro Environmental, Coronado, CA.

<u>Wood Fiber Mulch:</u> Wood fiber mulch shall be produced from natural or recycled (pulp) fiber, such as wood chips or similar wood materials, or from newsprint, corrugated cardboard, or a combination of these processed materials. The fibers shall not contain any rock, metal, or plastic. It shall be suitable for hydromulching and shall be treated with a nontoxic green dye to facilitate inspection of the placement of the material. It shall be manufactured in such a manner that after addition and agitation in slurry tanks with water, the fibers in the material will become uniformly suspended to form a homogenous slurry. When hydraulically sprayed on the ground, the material shall allow the absorption and percolation of moisture. The product shall contain less than 250 parts per million boron and shall be nontoxic to plant and animal life. The organic matter content shall be at least 93 percent on any oven-dry basis as determined by ASTM D586. The moisture content shall be no more than 15 percent as determined by oven-dried weight. Each package of the wood fiber mulch shall be marked by the manufacturer to show the dried weight. Wood fiber mulch shall be added to the tackifier at the rate of 1,500 pounds per acre minimum.

<u>Straw Mulch:</u> Straw mulch shall be air dried straw free of noxious weeds and other materials detrimental to plant life. Straw shall be seasoned before baling or loading. Straw mulch so provided shall be suitable for spreading with mulch blower equipment.

<u>Tackifier:</u> The tackifier shall be an organic guar tackifier derived form natural organic plant sources or a 100 percent polyacrylamide. The tackifier used shall contain no growth or germination inhibiting materials. The guar based tackifier shall be applied at a rate of 60 pounds per acre minimum. If polyacrylamide is used as the tackifier instead of guar, it shall be applied at 5 pounds per acre minimum.

<u>Erosion Control Matting:</u> Erosion control matting shall be used to prevent erosion of soil due primarily to wind. Erosion control matting shall be a long-life dense matting composed of nylon fiber, polyolefin fiber, or polyester fibers. The matting shall be of a consistent thickness with the fiber evenly distributed over the entire area of the matting. The fibers shall be encased between two layers of heavy polypropylene or polyolefin netting. The fibers and the netting shall be stitched top to bottom to form a three-dimensional matrix using polyester or polyolefin thread. All components of the erosion control matting shall be stabilized against ultraviolet degradation and inert to chemicals normally encountered in a natural soil environment. The erosion control matting shall have a minimum thickness of 0.5 inch and a minimum weight of 10 ounces per square yard. Three suggested product names for erosion

control matting are Landlok ECRM 450, Synthetic Industries, Chattanooga, TN; P300, North American Green, Evansville, IN; and Recylex TRM, American Excelsior Company, Arlington, TX.

Anchorage devices for erosion control matting shall be as recommended by the manufacturer of the erosion control matting and as approved by the Construction Manager.

Soil Stabilization Cover: Soil stabilization cover shall be applied on the finished grade inside side slopes of the Phase I excavation to reduce wind and water caused erosion. Soil stabilization cover shall be a waterborne copolymer emulsion consisting of nonflammable concentrated PVA liquid copolymer with acrylic base having 60 percent solids. On drying the soil stabilization cover shall from a colorless transparent net-like film. Such film shall have permeability to allow exchange of air and moisture and have an effective life of at least 1 year. The copolymer shall not re-emulsify when cured. The liquid copolymer emulsion shall be nontoxic to plants and animals. One suggested product name for soil stabilization cover is Marloc, Reclamare Company, Des Moines, WA.

PART 3--EXECUTION

PLACING TOPSOIL:

A 6-inch thick layer of topsoil, or as otherwise ordered by the Construction Manager, shall be evenly spread over all areas where material has either been excavated from or has been placed in that are to be seeded, including all borrow areas and permanent stockpiles.

Topsoil shall not be placed when the ground or topsoil is frozen, excessively wet, or in the opinion of the Construction Manager in a condition detrimental to the work.

Upon physical completion of the work, remaining topsoil shall be stockpiled at the location shown on the Drawings. The permanent topsoil stockpile shall than be seeded, fertilized, and mulched.

SEEDING, FERTILIZING, AND MULCHING:

General: Areas to be seeded, fertilized, and mulched are indicated on the Drawings. No seeding, fertilizing, and mulching shall be done within the Phase I excavation, unless directed otherwise by the Construction Manager. Areas to be seeded, fertilized, and mulched include at a minimum the east and west infiltration areas, the berm and ditch located south of the Phase I excavation, soil stockpiles that will remain after the completion of the construction, and borrow areas. Other areas outside of the Phase I excavation that are disturbed by the construction and are not otherwise stabilized shall be seeded, fertilized, and mulched as directed by the Construction Manager.

Season of Work: Seeding shall be done between September 1 and November 15. Specific ideal seeding times within this window shall be as required for proper seedbed preparation.

Weed Control: Areas to be seeded shall be maintained reasonably free of weeds. Weeds shall be kept from going to seed.

Seedbed Preparation: Soil shall be tilled to a minimum depth of 6 inches. The seedbed shall be firm below seeding depth and well pulverized and loose on top. It shall be free of clods and weeds. Tillage shall leave cross-slope furrows. Seedbed preparation shall not be performed when soil conditions are not suitable for tilling: too dry, too wet, frozen, etc.

Areas to be seeded that have not either had material excavated from them or placed in them shall not receive any seedbed preparation unless directed otherwise by the Construction Manager. The seedbed preparation would destroy any existing soil crust. Existing soil crust provides erosion protection.

Application of Seed and Fertilizer: Seeding and fertilizing shall be done closely following seedbed preparation and shall not be done during windy weather or when the ground is frozen or excessively wet. The Construction General Contractor shall notify the Construction Manager not less than 24 hours in advance of any seeding operation and shall not begin the work until areas prepared or designated for seeding have been approved. Following the Construction Manager's approval, seeding of the approved areas shall begin immediately.

Seed and fertilizer shall be applied by one of the following methods:

> Hydroseeding: Use a hydroseeder that utilizes water as the carrying agent, and maintains continuous agitation through paddle blades. It shall have an operating capacity sufficient to agitate, suspend, and mix into a homogeneous slurry the specified amount of seed and water or other material. Distribution and discharge lines shall be large enough to prevent stoppage and shall be equipped with a set of hydraulic discharge spray nozzles that will provide a uniform distribution of the slurry. Seed and fertilizer may be applied in one application provided that the fertilizer is placed in the hydroseeder tank no more than 1 hour prior to application.
>
> Hand Broadcasting: Apply fertilizer first. The seed shall be incorporated into the top 1/4 inch of soil by hand raking or other method that is approved by the Construction Manager.

Wood fiber mulch shall be added as a tracer to visibly aid uniform application. The application rate of wood fiber mulch used as a tracer shall not exceed 250 pounds per acre.

Seed shall be applied at a rate of 10 to 12 pounds pure live seed per acre. Fertilizer shall be applied at a rate of 1,000 pounds per acre.

Mulching: Straw mulch shall be evenly applied at a rate of 1.0 ton per acre within 48 hours after seeding. Mulching shall not be performed when wind interferes with mulch placement. Distribution of straw mulch material shall be by means of a mulch spreader that utilizes forced air to blow mulch material on the seeded areas. In spreading straw mulch, the spreader shall not cut or break the straw into short stalks. Straw mulch may be spread by hand over areas that were seeded by hand. Straw mulch shall be crimped into the soil to a depth of 2 inches and with no more than one pass of the equipment.

In areas where it is not possible to crimp the straw mulch into the soil, tackifier shall be applied over the straw mulch. The method of application for tackifier shall be in accordance with the manufacturer's instructions. The tackifier application rate shall be as specified herein. Tackifier shall be sprayed over mulch, seed, and fertilizer. The Construction Manager shall indicate which areas (if any) shall have the straw mulch held down with tackifier.

Protection: Traffic over seeded areas shall be prohibited.

Installation Warranty: The warranty period for seeding, fertilizing, and mulching will begin upon the date of acceptance of the completed installation. The installation shall be considered complete by the Construction Manager upon satisfactory completion of the initial inspection which is described below. Acceptance will be certified in writing by the Construction Manager.

Seeded areas shall be guaranteed by the Construction General Contractor for a period of 1 year. Mulch coverage will be used to evaluate the materials and workmanship of the application of seed, fertilizer, and mulch. Seed, fertilizer, and mulch will be reapplied one time only as directed by the Construction Manager at the Construction General Contractor's expense in areas where the coverage does not meet the following criteria. Three inspections of mulch coverage will occur:

> Initial inspection will occur between 1 to 3 business days following completion of the installation for the purposed of Construction Manager acceptance. Mulch coverage must equal 100 percent of the area over which it was spread before Construction Manager acceptance will occur.
>
> Mulch coverage will be inspected 60 days after Construction Manager acceptance at which time mulch coverage must equal 100 percent of the area over which it was spread.
>
> A final inspection will occur 30 days prior to the end of the warranty period. At this time, mulch coverage must equal at least 80 percent of the area over which it was spread.

PLACING EROSION CONTROL MATTING:

Erosion control matting shall be installed in the locations shown on the Plans and as directed by the Construction Manager. The erosion control matting shall be securely anchored to resist the wind. The erosion control matting shall be installed following the manufacturer's recommendations and the following minimum requirements. Where more than one strip of erosion control matting is required, it shall overlap the adjacent matting a minimum of 6 inches. The ends of the erosion control matting shall overlap a minimum of 6 inches with the uphill section on top.

PLACING SOIL STABILIZATION COVER:

Soil stabilization cover shall be applied with hydroseeding equipment in two passes of opposite directions. Copolymer shall be applied at a minimum rate of 200 gallons per acre; dilution rate for copolymer and water shall be per the manufacturer's recommendation. Wood fiber mulch shall be added as a tracer to visibly aid uniform application. The application rate of wood fiber mulch used as a tracer shall not exceed 250 pounds per acre.

Soil stabilization cover shall be applied when adequate weather conditions for proper curing, as determined by the manufacturer, are anticipated. The Construction General Contractor shall apply soil stabilization cover only to finish graded areas unless directed otherwise by Construction Manager.

END OF SECTION 02920

SECTION 09900–PAINT COATING SYSTEMS

PART 1–GENERAL

REFERENCES:

The following documents and others referenced therein form part of Contract to the extent designated. Referenced documents are those current, unless otherwise indicated.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI N512	Protective Coatings (paints) for the Nuclear Industry

ASTM INTERNATIONAL (ASTM)

ASTM D412	Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers- Tension
ASTM D570	Test Method for Water Absorption of Plastics
ASTM D638	Test Method for Tensile Properties of Plastics
ASTM D714	Test Method for Evaluating Degree of Blistering of Paints
ASTM D772	Test Method for Evaluating Degree of Flaking (Scaling) of Exterior Paints
ASTM D1653	Test Methods for Water Vapor Transmission of Organic Coating Films
ASTM D3912	Test Method for Chemical Resistance of Coatings Used in Light-Water Nuclear Power Plants
ASTM D4060	Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser
ASTM D4082	Test Method for Effects of Gamma Radiation on Coatings for Use in Light-Water Nuclear Power Plants
ASTM D4256	Test Method for Determination of the Decontaminability of Coatings Used in Light-Water Nuclear Power Plants
ASTM D4259	Standard Practice for Abrading Concrete
ASTM D4263	Test Method for Indicating Moisture Content in Concrete by the Plastic Sheet Method
ASTM D4541	Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
ASTM D5139	Sample Preparation for Qualification Testing of Coatings to be Used in Nuclear Power Plants
ASTM D5144	Guide for Use of Protective Coating Standards in Nuclear Power Plants

ASTM E84	Test Method for Surface Burning Characteristics of Building Materials

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 255	Method of Test of Surface Burning Characteristics of Building Materials

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC-SP 3	Power Tool Cleaning
SSPC-SP 6	Commercial Blast Cleaning

SUBMITTALS–APPROVAL REQUIRED:

See Section 01300, SUBMITTALS, for submittal procedures

List of Materials: Before delivery, submit colors and location to be used and manufacturer catalog data sheets and charts showing adequate information to substantiate compliance to the requirements of this section. Submittal shall also enumerate percentage of volatile and nonvolatile materials, percentage of component parts of each type of material, and the conversion factors to determine dry film thickness from applied wet film thickness. Also, submit Material Safety Data Sheets (MSDS) for materials proposed to be used.

Installer's Certificate (Decontaminable Coatings Only): Before application, submit documentation that the application crew has been certified by the coating system manufacturer as qualified to apply the selected coating system. As an alternative to crew certification, a submittal documenting onsite training by a technical representative from the coating manufacturer would be acceptable.

Cleaning and Disposal Plan: Before application, submit a plan for proper collection, storage, and disposal of all materials spotted or soaked with paint, oil, solvents, and other flammable waste materials. The plan shall also address handling and disposal of empty cans. The plan shall address both daily cleanup requirements and cleanup at the completion of the coatings application activities.

Submit documentation and test results from construction quality control testing specified herein.

DELIVERY, STORAGE, AND HANDLING:

Obtain inspection and acceptance by Tank Farm Contractor before opening containers or removing labels.

PROJECT CONDITIONS:

Environment for Coating: Coat exterior surfaces only when ambient and surface temperatures are within the range recommended by the coating manufacturer for the respective coating, which is within 40 to 120 degrees F, and ambient temperature is a minimum of 5 degrees F above the dewpoint.

PART 2--PRODUCTS

MATERIALS:

Shop Primer for Carbon Steel Assemblies: Ameron-Amerlock 400.

Decontaminable Coatings for all Metal and Concrete: (Service Level II as defined in ASTM D5144)

Decontaminability: Finish and top coatings shall demonstrate decontaminability to radioactive solutions by having a minimum decontamination factor (DF) of 100 as determined by ASTM D4256, Method A, or ANSI N512, Section 4. After the initial water wash, the DF shall be a minimum of 20. Test samples shall be prepared in accordance with ASTM D5139 or ANSI N512, Section 7.

Radiation Tolerance: Coatings applied to the specified thickness shall demonstrate tolerance to a total accumulated dose in air of 6×10^7 Rads of gamma radiation in accordance with ASTM D4082 or ANSI N512, Section 3. Test samples shall be prepared in accordance with ASTM D5139 or ANSI N512, Section 7.

Physical Properties: Base and finish coatings shall have the physical property strengths shown in the tables below as determined by the respective test method.

For Rigid Decontaminable Coatings (High Solids Epoxies):

Test	Method	Results
Adhesion to Substrate (steel)	ASTM D4541	Minimum 900 psi
Elongation at break at 75°F		Minimum 5%
Water Absorption or	ASTM D570 (24 hr)	Maximum 0.5%
Moisture Vapor Transmission	ASTM D1653	Maximum 8 gm/m^2
Wear Resistance (Finish or Top Coat Only)	ASTM D4060, 1,000 cycles, 1,000 g weight, CS-17 wheel	Less than 100 mg lost

Chemical Resistance: The coating system shall be resistant to the standard decontamination solutions listed in ASTM D3912, Figure 1. Chemical resistance testing shall be in accordance with ASTM D3912, or an equivalent standard, for occasional splash and spillage service, except test samples shall be prepared in accordance with ASTM D5139 or ANSI N512, Section 7. Submit manufacturer's chemical resistance test plan, including procedure for exposing coating samples for evaluating occasional splash and spillage conditions, for evaluation and approval. Criteria for acceptance shall be based on the following:

Flaking: As evaluated in accordance with ASTM D772, flaking and peeling shall not be permitted

Blistering: As evaluated in accordance with ASTM D714, blisters shall be limited to size 4, 6, or 8, and a frequency no more than a "few."

Delamination will not be permitted.

Slight discoloration will be permitted.

Coating shall be volatile organic content (VOC) compliant with a maximum VOC of 2.9 lbs/gal.

Fire Characteristics: Coatings used shall not develop significant qualities of toxic or other harmful products of combustion when exposed to fire. Coatings shall have a UL (ASTM E84/NFPA 255) flame spread rating of 25 or less and smoke developed rating of 50 or less.

Coatings shall be repairable for cracks appearing through the applied-coated surface to the substrate and for chips and flaking due to mechanical damage.

Coating shall have a design life of 12 years. In addition to radiation tolerance requirements, coating shall be resistant to humidity ranging from 0 to 100 percent and an ambient air temperature range of 120 degrees F to minus 32 degrees F, with a maximum 24-hour differential of 52 degrees F.

Primers, thinners, and coating accessory materials shall be produced or approved for use by the same manufacturer as the finish coating system.

Decontaminable Coating Systems (Epoxies), or Approved Substitute:

Manufacturer Product	Ameron
Steel and Concrete Primer	Amerlock 400
Concrete Surfacer	Nu-Klad 114A
Base Coating	Amerlock 400
Intermediate and Finish Coating	PSX 700 Siloxane

Joint Sealant: "Nu-Klad 750A/760A" by Ameron, or approved substitutes, shall be used.

Scrim Cloth: Glass fiber reinforcing fabric as recommended by coating system manufacturer.

PART 3--EXECUTION

EXAMINATION:

Examine surfaces scheduled to receive coatings for conditions that will adversely affect execution, performance, or quality of work, and that cannot be put into acceptable condition through preparatory work.

Report conditions that could adversely affect proper application of coatings, in writing, to Tank Farm Contractor. Do not begin surface preparation or coating application until defects have been corrected and conditions have been made suitable.

PREPARATION:

Before application, remove as much dust and debris as possible from space or area to receive coating to allow for proper installation.

Pre-Priming:

Ferrous Metal and Carbon Steel:

Remove oil, grease, welding fluxes, and other surface contaminants prior to blast cleaning.

Prepare shop assemblies in accordance with SSPC-SP 6. Remove abrasive residue and dust, and prime within 4 hours after preparation. Apply minimum of 3.0 mil of shop primer in accordance with manufacturer's recommendations.

Select type and size of abrasive to produce a surface profile that meets coating manufacturer's recommendations for particular primer to be used.

Prepare field erections in accordance with SSPC-SP 3 or SSPC-SP 6. Remove abrasive residue and dust.

Surface Preparation: Shop and field surface cleaning and surface preparation requirements for all substrates shall be in accordance with the manufacturer's written instructions and these Specifications. Where the specified degree of surface preparation differs from the manufacturer's recommendations, the more stringent shall apply.

Concrete shall be at least 30 days old before coating is applied.

Prior to application of coating system or surfacer to new concrete surfaces, perform a plastic sheet test in accordance with ASTM D4263. The test shall be initiated in the afternoon and completed the following morning. The absence of condensation on the test sheet shall indicate the concrete is ready to have the coating system applied. Document test results.

Clean new concrete surfaces to be coated by Abrasive Blast Cleaning Procedures in accordance with ASTM D4259.

Prepare or repair construction joints, shrinkage cracks, and other non-expanding cracks, gaps, or crevices in the surface to be coated, in accordance with coating manufacturer's recommendations. Scratches, cracks, holes, pinholes, and abrasions shall be cut back to proper key and filled with surfacer.

Post-Priming:

Feather abrasions, chips, skips, and holidays occurring in prime coat by sanding, and recoat with material and color to minimum dry film thickness specified.

Previously coated surfaces shall be recoated only after existing film is completely dry. Some coating systems require the application of succeeding coats within a set time frame for it to properly adhere to the previous coat. Should the time frame recommended by the coating manufacturer be exceeded, prepare the base coat as recommended by the coating manufacturer.

Protection:

Provide and install drop cloths, shields, and other protective devices required to protect surfaces adjacent to areas being coated. Keep spatter, smears, droppings, and over-run of coating materials to a minimum and remove as coating work progresses.

Protect coating from rain until dry to touch.

Upon completion of each coating application, protect coated surfaces from physical damage or chemical contamination.

APPLICATION:

Apply coating materials in accordance with manufacturer's recommendations.

Apply with equipment recommended by coating manufacturer.

Number of Coats, Film Thickness:

Apply the minimum number of coats specified without regard to coating thickness. Additional coats may be required to obtain minimum required paint thickness, depending on method of application, differences in manufacturers' products, and atmospheric conditions.

Maximum film build per coat shall not exceed coating manufacturer's recommendations.

Give particular attention to edges, angles, flanges, and other similar areas, where insufficient film thickness is likely to be present, and ensure proper millage in these areas.

Sealant Application:

Rigid Coating Systems: After pre-primer is installed (see Article COAT SCHEDULE), apply sealant to expansion joints at the coated surface boundary. Mask limits of joint to provide a neat appearance. Roughen contact surfaces with sandpaper. Prime and install sealant in accordance with manufacturer's instructions.

Identify each coat of opaque material by its relation to color of finish coat. Prime coat shall be darkest tint of specified color with each succeeding coat lighter, up to finish coat, which shall be color, tint, and sheen specified in Article COAT SCHEDULE or as shown on the Drawings. Tints of identical coats of identical color and material shall not vary.

Recoat and repair as necessary for compliance with the Specifications.

CLEANING:

Collect and dispose of materials spotted or soaked with paint, oil, or solvents, and other flammable waste materials daily in accordance with the coating manufacturer's recommendations. Minimize volume of potentially contaminated solids and liquids that must be disposed.

Salvageable brushes, rollers, spatulas, and spray equipment shall be thoroughly cleaned after use and shall contain no oils, thinners, or other residue after cleaning.

Dispose of empty cans at end of each shift in accordance with the cleaning and disposal plan.

At completion of coating work, remove and dispose of materials, containers, rags, cloths, brushes, equipment, and miscellaneous other debris in accordance with the cleaning and disposal plan. Clean up spills and report, if required, in accordance with the cleaning and disposal plan.

CONSTRUCTION QUALITY CONTROL:

The Construction General Contractor shall perform the field tests specified herein with properly calibrated instruments. All testing shall be performed and recorded by personnel trained in the use of the test instruments.

Thickness Testing:

Measure coating thickness on steel with a properly calibrated, magnetic type dry film thickness gauge (as manufactured by Nordson; or approved equal).

Measure the wet film thickness (WFT) of each coat of material with a notched WFT gage (Nordson 790-015) at a minimum of five evenly spaced points for each 100 square feet of surface area or portion thereof to verify the application will provide the specified minimum dry film thickness.

Adhesion Testing:

Perform adhesion testing at each field or shop location where surfaces are prepared and coatings are applied.

After surface preparation and coating application procedures have been observed and approved by the paint manufacturer's representative, select one representative location for an adhesion pull test. If the adhesion pull test does not meet the specified requirement, perform additional pull tests to determine the area of inadequate adhesion. Remove and replace coatings with inadequate adhesion.

If changes are observed in the shop or field application procedures that may affect coating adhesion, Construction Manager may require additional adhesion tests.

Construction General Contractor shall provide all test equipment required for adhesion testing.

Repair all coatings damaged by adhesion testing in accordance with the coating manufacturer's directions.

Inspection: Perform tests to ascertain that coating materials have been applied as specified in this section. Document test results. Document surface preparation, application of all coats of material, and performance of wet and dry film thickness testing in accordance with this section.

Perform water tightness test of concrete sumps in accordance with Component Construction Acceptance Test as provided in the Construction Inspection Plan, RPP-18490, Rev. 0.

APPLICATION SCHEDULE:

Concrete: Coat exposed concrete surfaces of building slabs, truck loading slab, sump, and other concrete surfaces as shown on the Drawings.

Carbon Steel:

Coat all exposed carbon steel with the coating system specified in Article COATING SCHEDULE.

Coat concrete embedded anchor bolts with carbon steel coating system; delete intermediate and finish coats for concrete embedded anchor bolts. Repair coating on threads after nuts are installed in accordance with the manufacturer's recommendations.

See Section 13122, METAL BUILDING SYSTEMS, for painting requirements associated with prefabricated steel buildings and Section 13205, LINED BOLTED STEEL LIQUID STORAGE TANKS, for painting requirements associated with the bolted steel tank.

Aluminum and Galvanized Steel in Contact with Concrete: Coat aluminum and galvanized steel in contact with concrete with carbon steel coating system, primer only. Provide a minimum dry film thickness of 4 mils.

COAT SCHEDULE:

Coat	Description	Color (*see Note 1)	Minimum Dry Film μm (mils)
Concrete – Rigid Coating System (Epoxies):			
Pre-Prime	Amerlock 400-thinned approx. 20-25% with #65 thinner.	N/A	Enough to seal surface
Joint Sealer	NuKlad 760A	N/A	N/A
Surfacer	NuKlad 114A	N/A	As required to fill voids
Prime and Base	Amerlock 400	*	Two coats: Prime 75 (3.0) Base 100 (4.0)

Coat	Description	Color (*see Note 1)	Minimum Dry Film µm (mils)
Intermediate and Finish. Between coats wipe entire surface with clean thinner #65, #12, or equal.	PSX 700 Siloxane	*	Two coats: Intermediate 100 (4.0) Finish 100 (4.0) (See Note 2)
Carbon Steel:			
Shop and Field Primer	Amerlock 400, see Note 3	*	75 (3.0)
Base	Amerlock 400, see Note 3	*	100 (4.0)
Intermediate	See Note 4 PSX 700 Siloxane	*	100 (4.0)
Finish	PSX 700 Siloxane	*	100 (4.0)

Notes:

1. Contrast each coat from primer-darker to finish-lighter. Finish coat to be off-white to white, except bollards and truck loading connection piping support which shall be yellow.
2. Verify recoating times between intermediate and finish coats with the coating manufacturer if relative humidity is less than 40 percent.
3. Prime and base coats may be applied in single 180 µm coat if base coat is self-priming.
4. For anchor bolts, delete intermediate and finish coats.

END OF SECTION 09900

SECTION 11306--LEACHATE PUMPS

PART 1--GENERAL

GENERAL:

Provide multi-stage, centrifugal, submersible pumps specifically designed for landfills and sideslope installations. Pumps shall be designed for pumping contaminated water and leachate. Provide all necessary pump appurtenances including lifting cable for lowering and removing the pump, power cable, a minimum 4-wheel system at each end of the pump specifically designed for transporting the pump in HDPE butt-fused carrier pipe, outlet pipe attachments and flex hose as necessary, and all other fittings or accessories required for a complete and fully functional installation.

The pump and all associated appurtenances shall be designed by the pump manufacturer to operate as a fully functional and reliable pump system. Provide a pump system capable of operating unattended with a high degree of reliability with multiple cycles per day.

Provide vent valve system, if necessary, to purge air from pumps to prevent pump air lock. Vacuum air release valves are provided in system piping at top of riser.

Provide quick-couple fitting at end of pump where outlet pipe attaches.

Remove pump discharge check valve or drill hole in check valve to prevent water from accumulating above pump outlet. Pump shall be fully capable of operating with check valve removed.

Provide stainless steel tag numbers and mounting fasteners and engrave with the equipment tag number and model number for each pump.

Note that pump control will be accomplished through software programming and the PLC mounted in the system control panels (by others) located in each Crest Pad Building.

SUBMITTALS–APPROVAL REQUIRED:

See Section 01300, SUBMITTALS, for submittal procedures.

Make, model, weight, and horsepower of each equipment assembly.

Complete catalog information, descriptive literature, specifications, and identification of materials of construction.

Performance data curves showing head, capacity, horsepower demand, and pump efficiency over the entire operating range of the pump, from shutoff to maximum capacity. Indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at the guarantee point.

Functional testing plan demonstrating compliance with requirements specified herein.

Detailed mechanical and electrical drawings showing the equipment dimensions, size, and locations of connections and weights of associated equipment.

Detailed catalog information, descriptive literature, and specifications of all components associated with pump removal system.

Power and control wiring diagrams, including terminals and numbers.

Complete motor nameplate data, as defined by NEMA, motor manufacturer.

Results of source quality control testing.

<u>SUBMITTALS–APPROVAL NOT REQUIRED:</u>

<u>Information/Record (IR):</u>

Manufacturer's certification of factory testing to establish conformance with specified requirements. Certification must include certificates of calibration traceable to a nationally recognized standards organization such as National Institute of Standards and Technology (NIST).

Special shipping, storage and protection, and handling instructions.

Manufacturer's Certificate of Proper Installation.

Results of field quality control testing.

<u>Vendor Information (VI):</u>

Suggested spare parts list to maintain the equipment in service for a period of 1 year. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.

List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.

Manufacturer's printed installation instructions.

Operation and maintenance manual.

PART 2--PRODUCTS

PUMPS:

All major components shall be Type 304 stainless steel including the housing, fasteners, shaft, diffuser chamber, and impeller(s). Components shall be highly corrosion resistant and suitable for contaminated water and leachate service. Gaskets, O-rings, and seals shall have compatibility properties equivalent to Viton material as a minimum.

Pump bearings shall have better heat and wear resistance than Teflon bearings.

Provide power and stainless steel cable as recommended by manufacturer and to the length and configuration as shown on the Drawings.

Motors:

Provide sealed pump motors suitable for continuous submerged service. Provide continuous motor leads without splices along the full length of the discharge pipe. Leads shall be fully insulated with chemical and waterproof insulation properties. Provide motor designed for continuous duty and multiple cycle times of 60 starts per hour. Motors shall have thermal overload protection.

Source Quality Control:

Construction General Contractor shall perform source quality testing at the factory as specified herein. Notify Construction Manager in writing at least 10 days in advance of testing. Construction Manager will coordinate with personnel required to witness testing.

Factory Tests and Adjustments: Test all equipment actually furnished.

Factory Test Report: Include test data sheets, curve test results, performance test logs.

Performance Test:

Conduct on each pump.

Perform under simulated operating conditions, at a minimum of six operating points on the pump curve.

Test for a continuous 30-minute period without malfunction. Check for excessive or abnormal vibrations and correct deficiencies.

Test Log: Record the following:

Total head.

Flow measured by factory instrumentation and/or storage volumes.

Average distance from suction well water surface to pump discharge centerline for duration of test.

Pump discharge pressure converted to feet of liquid pumped and corrected to pump discharge centerline.

Driving motor voltage and amperage measured for each phase.

Adjust or modify units and retest if necessary.

Pump Removal System:

Provide one common manual pump removal winch for raising and lowering the leachate pumps and associated discharge piping in the riser. Winch shall be brake (spur gear) winch with automatic brake; Thern Model No. M4032PB, or equal. Provide winch with sufficient capacity to handle required length of lifting cable (stainless steel wire rope). Lifting cable shall include and the winch accommodate a swage ball fitting cable end for quick connect/disconnect.

Winch shall be mounted on structural steel support. The winch support shall only be installed for pump installation/removal. Three sets of drop-in anchors shall be installed in floor that match the winch support base bolt pattern. Each set of drop-in anchors shall be located to align the winch support with each HDPE riser pipe such that the lifting cable does not rub the HDPE riser pipe during pump installation/ removal. Coordinate location of the drop-in anchors with Construction Manager.

Provide two manual hose reels for separately handling the leachate pump power and level transducer cables. Hose reels shall be heavy-duty hand crank reels with adjustable spool rotation drag and spool lock pins. Hose reels shall be Reelcraft Model No. C33118LI, or equal. Each reel shall be located as required for proper alignment with appropriate riser pipe. Drop-in anchors shall be installed in floor that match hose reel "feet" bolt pattern for both reels. Bolts shall be left in place to prevent accumulation of dirt, etc., in anchor threads. Bolts shall be tapered flathead to eliminate tripping hazard.

LEVEL SENSORS:

Provide level sensors integral to Cell 1 and Cell 2 LDS leachate pump (two total) as shown on the Drawings. Level elements shall be designed and constructed for landfill leachate service, i.e., fully submersible and chemically resistant.

The level sensor shall include a transmitter with built-in temperature compensation and an accuracy of plus or minus 1.0 percent. Sensor output shall be a conditioned compensated 4 to 20 mA signal.

The sensor control cable shall be shielded to prevent signal disruption and include a vent tube for atmospheric pressure compensation. Control cables shall include polyurethane jacket and Kevlar tension members.

Level sensors shall be mounted on the pump housing and be field serviceable without having to disassemble the pump.

PART 3--EXECUTION

INSTALLATION:

Install in accordance with manufacturers' printed instructions and manufacturers' representatives' guidance and recommendations.

CONSTRUCTION QUALITY CONTROL:

Construction General Contractor shall perform functional testing in accordance with approved testing plan. Functional testing shall be performed in the presence of the Construction Manager. Notify Construction Manager in writing at least 5 days in advance of testing.

Function Tests:

Prior to the pump and level transducer insertion tests identified in the Component CAT procedures, verify the LCRS, LDS, and SLDS riser pipe transition from the side slope to the horizontal portion of the riser pipe is adequate for leachate pump and level transducer insertion. Perform the pump/level transducer insertion tests prior to backfilling and after the riser pipe installation is finished from within the sump to a location approximately 50 feet up the side slope. Perform the pump/level transducer insertion tests using the associated leachate pump or level transducer for each riser. In addition to the level transducer insertion for the SLDS riser pipe, test the transition using the LDS low-flow leachate pump as well. If actual level transducers or leachate pumps are not available at the time of the testing, "dummy" level transducers and pumps can be used per approval from CHG Construction Manager.

After complete installation of the side slope riser pipe from the sump to the crest pad building, verify exact length of pump discharge and level transducer piping required by using a long tape measure to measure actual dimension. Test the insertion and extraction of each pump from the side slope riser pipe and into the crest pad buildings. Perform testing while the perforated carrier pipe sections in the sumps are exposed to allow observation of the pump removals and insertions from the carrier pipe.

Test the pumps under simulated conditions using a temporary tank located at the bottom of the landfill. Place pump in the tank and connect temporary flexible hose between the pump and discharge pipe routed up the side slope surface and between the discharge pipe and riser connection in Crest Pad Building. ~~Run the pumps at full output for a period of not less than 1 hour. Record flows and pressures at 10-minute intervals and/or until readings stabilize.~~ Keep the tank full to supply adequate water to the pumps during the pump test. Record amp draw readings.

SUPPLEMENTS:

The supplements listed below, following "END OF SECTION," are a part of this Specification.

Data Sheets:

Supplement 1—Leachate Pump Data Sheet, 11306-01.
Supplement 2—Leachate Pump Data Sheet, 11306-02.
Supplement 3—Leachate Pump Data Sheet, 11306-03.

END OF SECTION 11306

LEACHATE PUMP DATA SHEET, 11306-01:

Tag Numbers: 219A-LH-P-202, 219E-LH-P-202

Pump Locations and I.D.: Cell 1 LCRS Sump, Low Flow
Cell 2 LCRS Sump, Low Flow

Manufacturer and Model Number: (1) EPG Companies; Model WSD 3-3
(2) Or equal

SERVICE CONDITIONS:

Liquid Pumped (Material and Percent): Leachate from low-level radioactive waste landfill

Pumping Temperature (Fahrenheit): Normal: 55 F Max: 130 F Min: 27 F

Specific Gravity at 60 Degrees F: 1.0 Viscosity Range: NA pH: 5-9

Abrasive (Y/N) Y (infrequent fine soil particles) Possible Scale Buildup (Y/N): Y

Total Suspended Solids (mg/l): 200 (estimated)

PERFORMANCE REQUIREMENTS AT PRIMARY DESIGN POINT:

Capacity (US gpm): Rated: 13

Total Dynamic Head (Ft): Rated: 66

Min. Hydraulic Efficiency (%): 60

Maximum Shutoff Pressure (Ft): 90

Max. Pump Speed at Design Point (rpm): 3,450

Constant (Y/N): Y Adjustable (Y/N): N

DESIGN AND MATERIALS:

Design: Wheeled enclosure frame   Back Pullout (Y/N) Y

Discharge Orientation: Center

Casing Materials: Type 304 SST

Case Wear Ring (Y/N) NA   Material: NA

Impeller: Type: Closed   Material: Type 304 SST

Impeller Wear Ring (Y/N): Y   Material: E-Glide (engineered plastic) or equal

Shaft Material: Type 304 SST   Shaft Sleeve Material: E-Glide or equal

Shaft Seal: Y   Ring Material: E-Glide or equal   Lubrication: Fluid

AFBMA B-10 Bearing Life (Hrs): NA   Lubrication: NA

Drive Type: Direct Coupled

INDUCTION DRIVE MOTOR:

Horsepower: 0.5   Voltage: 460   Phase: 3

Speed (rpm): 3,450

Service Factor: 1.15   Inverter Duty (Y/N) N

Motor nameplate horsepower shall not be exceeded at any head-capacity point on the pump curve.

Enclosure: Submersible

LEACHATE PUMP DATA SHEET, 11306-02:

Tag Numbers: 219A-LH-P-203, 219E-LH-P-203

Pump Location and I.D.: Cell 1 LCRS Sump, High Flow
Cell 2 LCRS Sump, High Flow

Manufacturer and Model Number: (1) EPG Companies; Model WSD 30-4
(2) Or equal

SERVICE CONDITIONS:

Liquid Pumped (Material and Percent): Leachate from low-level radioactive waste landfill

Pumping Temperature (Fahrenheit): Normal: 55 F Max: 130 F Min: 27 F

Specific Gravity at 60 Degrees F: 1.0 Viscosity Range: NA pH: 5-9

Abrasive (Y/N) Y (infrequent fine soil particles) Possible Scale Buildup (Y/N): Y

Total Suspended Solids (mg/l): 200 (estimated)

PERFORMANCE REQUIREMENTS AT PRIMARY DESIGN POINT:

Capacity (US gpm): Rated: 155

Total Dynamic Head (Ft): Rated: 118

Min. Hydraulic Efficiency (%): 60

Maximum Shutoff Pressure (Ft): 208

Max. Pump Speed at Design Point (rpm): 3,450

Constant (Y/N): Y Adjustable (Y/N): N

DESIGN AND MATERIALS:

Design: Wheeled enclosure frame (Y/N) Y

Discharge Orientation: Center

Casing Materials: Type 304 SST

Case Wear Ring (Y/N) NA Material: NA

Impeller: Type: Closed Material: Type 304 SST

Impeller Wear Ring (Y/N): Y Material: E-Glide (engineered plastic), or equal

Shaft Material: Type 304 SST Shaft Sleeve Material: E-Glide (engineered plastic), or equal

Shaft Seal: Y Ring Material: E-Glide or equal Lubrication: Fluid

AFBMA B-10 Bearing Life (Hrs): NA Lubrication: NA

Drive Type: Direct Coupled

INDUCTION DRIVE MOTOR:

Horsepower: 7.5 Voltage: 460 Phase: 3

Speed (rpm): 3,450

Service Factor: 1.15 Inverter Duty (Y/N) N

Motor nameplate horsepower shall not be exceeded at any head-capacity point on the pump curve.

Enclosure: Submersible

LEACHATE PUMP DATA SHEET, 11306-03:

Tag Numbers: 219A-LH-P-204, 219E-LH-P-204

Pump Locations and I.D.: Cell 1 LDS Sump
Cell 2 LDS Sump

Manufacturer and Model Number: (1) EPG Companies; Model WSD 1.5-3
(2) Or equal

SERVICE CONDITIONS:

Liquid Pumped (Material and Percent): Leachate from low-level radioactive waste landfill

Pumping Temperature (Fahrenheit): Normal: 55 F Max: 130 F Min: 27 F

Specific Gravity at 60 Degrees F: 1.0 Viscosity Range: NA pH: 5-9

Abrasive (Y/N) Y (infrequent fine soil particles) Possible Scale Buildup (Y/N): Y

Total Suspended Solids (mg/l): 200 (estimated)

PERFORMANCE REQUIREMENTS AT PRIMARY DESIGN POINT:

Capacity (US gpm): Rated: 4

Total Dynamic Head (Ft): Rated: 65

Min. Hydraulic Efficiency (%): 60

Maximum Shutoff Pressure (Ft): 80

Max. Pump Speed at Design Point (rpm): 3,450

Constant (Y/N): Y Adjustable (Y/N): N

DESIGN AND MATERIALS:

Design: Wheeled enclosure frame   Back Pullout (Y/N) Y

Discharge Orientation: Center

Casing Materials: Type 304 SST

Case Wear Ring (Y/N) NA   Material: NA

Impeller: Type: Closed   Material: Type 304 SST

Impeller Wear Ring (Y/N): Y   Material: E-Glide (engineered plastic) or equal

Shaft Material: Type 304 SST   Shaft Sleeve Material: E-Glide or equal

Shaft Seal: Y   Ring Material: E-Glide or equal   Lubrication: Fluid

AFBMA B-10 Bearing Life (Hrs): NA   Lubrication: NA

Drive Type: Direct Coupled

INDUCTION DRIVE MOTOR:

Horsepower: 0.5   Voltage: 460   Phase: 3

Speed (rpm): 3,450

Service Factor: 1.15   Inverter Duty (Y/N) N

Motor nameplate horsepower shall not be exceeded at any head-capacity point on the pump curve.

Enclosure: Submersible

SECTION 11312--HORIZONTAL END SUCTION CENTRIFUGAL PUMPS

PART 1--GENERAL

REFERENCES:

The following is a list of standards which may be referenced in this section:

AMERICAN BEARING MANUFACTURERS' ASSOCIATION (ABMA)

AMERICAN IRON AND STEEL INSTITUTE (AISI)

Type 416 Stainless Steel
Type 1035 Steel
Type 1045 Carbon Steel
Type 4140 Alloy Steel

ASTM INTERNATIONAL (ASTM)

ASTM A48	Standard Specification for Gray Iron Castings
ASTM A53/A53M	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A276	Standard Specification for Stainless Steel Bars and Shapes
ASTM A576	Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality
ASTM B62	Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B148	Standard Specification for Aluminum-Bronze Sand Castings
ASTM B584	Standard Specification for Copper Alloy Sand Castings for General Applications

HYDRAULIC INSTITUTE STANDARDS

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 112	Standard Test Procedure for Polyphase Induction Motors and Generators

NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATION (NEMA)

NEMA MG 1	Motors and Generators

DEFINITIONS:

Terminology pertaining to pumping unit performance and construction shall conform to the ratings and nomenclature of the Hydraulic Institute Standards.

SUBMITTALS–APPROVAL REQUIRED:

See Section 01300, SUBMITTALS, for submittal procedures.

Make, model, weight, and horsepower of each equipment assembly.

Complete catalog information, descriptive literature, specifications, and identification of materials of construction.

Performance data curves showing head, capacity, horsepower demand, and pump efficiency over the entire operating range of the pump, from shutoff to maximum capacity. Indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at the guarantee point.

Detailed mechanical and electrical drawings showing the equipment dimensions, size, and locations of connections and weights of associated equipment.

Functional testing plan demonstrating compliance with requirements specified herein.

Power and control wiring diagrams, including terminals and numbers.

Complete motor nameplate data, as defined by NEMA, motor manufacturer.

Results of source quality control testing.

SUBMITTALS–APPROVAL NOT REQUIRED:

Information/Record (IR):

Special shipping, storage and protection, and handling instructions.

Manufacturer's Certificate of Proper Installation.

Results of field quality control testing.

Vendor Information (VI):

Suggested spare parts list to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.

List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.

Manufacturer's printed installation instructions.

Operation and maintenance data.

Factory finish system data sheets.

EXTRA MATERIALS:

Furnish for each pump:

Complete set packing.

Complete set bearings.

Complete set gaskets and O-ring seals.

Complete set of shaft sleeves.

Complete set keys, dowels, pins, etc.

Complete mechanical seal.

Impeller.

Impeller shaft.

Impeller wear ring.

Head shaft.

One complete set of any special tools required to dismantle pump.

PART 2–PRODUCTS

GENERAL:

Coordinate pump requirements with drive manufacturer and be responsible for pump and drive requirements.

Where adjustable speed drives are required, furnish a coordinated operating system complete with pump, drive, and speed controller.

SUPPLEMENTS:

Some specific requirements are attached to this section as supplements.

ACCESSORIES:

Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in a readily visible location.

Lifting Lugs: Equipment weighing over 100 pounds.

Anchor Bolts: Galvanized, sized by equipment manufacturer, 1/2-inch minimum diameter, and as specified in Section 05500, METAL FABRICATIONS AND CASTINGS.

FACTORY FINISHING:

Manufacturer's standard enamel finish.

SOURCE QUALITY CONTROL:

Construction General Contractor shall perform source quality control testing at the factory as specified herein. Notify Construction Manager at least 10 days in advance of testing.

Performance Test: Perform manufacturer's standard motor test on equipment.

PART 3--EXECUTION

INSTALLATION:

Install in accordance with manufacturer's printed instructions.

Level base by means of steel wedges (steel plates and steel shims). Wedge taper not greater than 1/4 inch per foot. Use double wedges to provide a level bearing surface for pump and driver base. Accomplish wedging so that there is no change of level or springing of the baseplate when the anchor bolts are tightened.

Adjust pump assemblies such that the driving units are properly aligned, plumb, and level with the driven units and all interconnecting shafts and couplings. Do not compensate for misalignment by use of flexible couplings.

After pump and driver have been set in position, aligned, and shimmed to proper elevation, grout the space between the bottom of the baseplate and the concrete foundation with a poured, nonshrinking grout. Remove wedges after grout is set and pack void with grout.

Connect suction and discharge piping without imposing strain to pump flanges.

Anchor Bolts: Accurately place using equipment templates and as specified in Section 05500, METAL FABRICATIONS AND CASTINGS.

CONSTRUCTION QUALITY CONTROL:

Construction General Contractor shall perform field quality control testing in accordance with approved testing plan. Functional testing shall be performed in the presence of the Construction Manager. Notify Construction Manager in writing at least 5 days in advance of testing.

Functional Tests:

Conduct on each pump.

~~Perform under simulated operating conditions.~~

Test for a continuous 1/2-hour period without malfunction.

Test Log: Record the following:

Total head.

Capacity.

~~Horsepower requirements.~~

Flow measured by factory instrumentation and/or storage volumes.

Average distance from suction well water surface to pump discharge centerline for duration of test.

Pump discharge pressure converted to feet of liquid pumped and corrected to pump discharge centerline.

Driving motor voltage and amperage measured for each phase.

Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.

~~Vibration Test:~~

~~Test with units installed and in normal operation, and discharging to the connected piping systems at rates between the low discharge head and high discharge head conditions specified shall not develop, at any frequency or in any plane, peak-to-peak vibration amplitudes of 3 mils.~~

~~If units exhibit vibration in excess of the limits, adjust or modify as necessary. Units which cannot be adjusted or modified to conform as specified shall be replaced.~~

Operating Temperatures: Monitor bearing areas on pump and motor for abnormally high temperatures.

MANUFACTURER'S SERVICES:

Manufacturer's Representative: Present at site or classroom designated by Tank Farm Contractor, for minimum person-days listed below, travel time excluded:

1 person-day for installation assistance and inspection.

1 person-day for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.

SUPPLEMENTS:

The supplements listed below, following "END OF SECTION," are a part of this Specification.

Pump Data Sheet, 11312-01

END OF SECTION 11312

HORIZONTAL END SUCTION CENTRIFUGAL PUMP DATA SHEET, 11312-01:

Tag Numbers: 219A1-LH-P-302, 219E1-LH-P-302

Pump Name: Buildings 219A1 and 219E1, Leachate Transfer Pump

Manufacturer and Model Number: (1) Paco; Model 30707
(2) Or equal

SERVICE CONDITIONS:

Liquid Pumped (Material and Percent): Leachate from low-level radioactive waste landfill

Pumping Temperature (Fahrenheit): Normal: 55 Max 130 Min 27

Specific Gravity at 60 Degrees F: 1.0 Viscosity Range: NA pH: 5-9

Abrasive (Y/N) Y (fine soil particles) Possible Scale Buildup (Y/N): Y

Total suspended solids (mg/L) 200 (estimated)

Largest diameter solid pump can pass (inches) 0.25

PERFORMANCE REQUIREMENTS AT PRIMARY DESIGN POINT:

Capacity (US gpm): Rated: 250

Total Dynamic Head (Ft): Rated: 25

Min. Hydraulic Efficiency (%): 75

Maximum Shutoff Pressure (Ft): 40

Max. Pump Speed at Design Point (rpm): 1,750

Constant (Y/N): Y Adjustable (Y/N): N

DESIGN AND MATERIALS:

ANSI (Y/N) Y   Standard (Y/N) Y   Design: Frame-mounted (Y/N) Y

Close-Coupled Casing (Y/N) N   Back Pullout (Y/N) Y

Discharge Orientation: 12:00   Rotation (view from end coupling): CW

Shaft Seal: Packing (Y/N) N

Mechanical (Y/N) Y

Lubrication: Process water

Drive Type: Direct-Coupled: Y   Belt N   Adjustable Speed N

INDUCTION DRIVE MOTOR:

Horsepower: 3 Voltage: 460 Phase: 3 Speed (rpm): 1,750

Service Factor: 1.15 Inverter Duty (Y/N) N

Motor nameplate horsepower shall not be exceeded at any head-capacity point on the pump curve.

Enclosure: Totally enclosed fan cooled

Mounting Type: Horizontal Y   Nonreverse Ratchet (Y/N) N

TESTING:

Pump Tests: Factory Functional (Y/N) N   Field Performance (Y/N) N

Factory Hydrostatic Casing Pressure Test (Y/N) N

Field Functional (Y/N) Y   Field Performance (Y/N) N

Field Vibration (Y/N) Y

SECTION 13122--METAL BUILDING SYSTEMS

PART 1--GENERAL

WORK INCLUDED:

The Construction Subcontractor shall furnish and install four prefabricated pre-engineered metal building, complete, as shown on the Drawings and as specified herein.

REFERENCES:

The following Codes and Standards, including others referenced therein, form a part of this Section to the extent specified herein:

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC	Specification for Structural Steel for Buildings – Allowable Stress Design (ASD)

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI	Specification for the Design of Cold-Formed Steel Structural Members

ASTM INTERNATIONAL (ASTM)

ASTM A36	Standard Specification for Carbon Structural Steel
ASTM A53	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A325	Standard Specification for Structural Bolts, Steel, Heat-Treated, 120/105 ksi Minimum Tensile Strength
ASTM A500	Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A501	Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
ASTM A529	Standard Specification for High-Strength Carbon-Manganese Steel of Structural Quality
ASTM A570	Standard Specification for Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality
ASTM A572	Standard Specification for High-Strength, Low-Alloy Columbium-Vanadium Structural Steel
ASTM A607	Standard Specification for Steel, Sheet and Strip, High-Strength, Low-Alloy, Columbium or Vanadium, or Both, Hot-Rolled, and Cold-Rolled

ASTM F959	Standard Specification for Compressible-Washer-Type Direct Tension Indicator for Use with Structural Fasteners

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1	Structural Welding Code – Steel

METAL BUILDING MANUFACTURERS ASSOCIATION (MBMA)

Recommended Design Practices Manual, for applicable loads and load combinations

Metal Building Systems Manual, for collateral loads

INTERNATIONAL CONFERENCE OF BUILDING OFFICIALS (ICBO)

UBC, Uniform Building Code

STEEL DOOR INSTITUTE (SDI)

SDI 100	Recommended Specifications for Standard Steel Doors and Frames
SDI 117	Manufacturing Tolerances Standard Steel Doors and Frames

SUBMITTALS–APPROVAL REQUIRED:

See Section 01300, SUBMITTALS, for submittal procedures.

Shop Drawings:

Manufacturer's Standard Details and Structural Calculations: Clearly mark those portions that apply to specific Project and those parts that do not apply.

Manufacturer's Literature and Technical Data: Drawings and Specifications for proposed metal building system.

Painting System: Specifications including paint manufacturer's name, product trade-name, and preparation for shop and field coats. Provide minimum 20 color samples for Tank Farm Contractor to choose.

Drawings Stamped by Engineer Registered in the State of Washington and Prepared Specifically for this Project:

Materials and Details: Show materials, details of components (including doors and other accessories), finishes, fastenings, methods of joining, sealants, anchor bolt, shear angle, and baseplate details including all sizes and dimensions, size and location of structural members and bracing, wall structural members, bracing, openings, and structural wind columns as required.

Calculations Stamped by Engineer Registered in the State of Washington: Complete structural stress and deflection analysis of structural components and connections; consider prying action of bolts should proposed design use bolted moment-resistant connections in main frames. Provide anchor bolt calculations and separately tabulate anchor bolt reaction for all case loads and load combinations.

Samples: Minimum 2-inch by 3-inch metal for components requiring color selection.

Submit documentation of construction quality control testing as specified herein.

SUBMITTALS–APPROVAL NOT REQUIRED:

Information/Record (IR):

Statements of Qualification:

Documentation of past 5 years' experience record to include project name, location, type and date completed, building manufacturer and owner's contact person.

Certification of approval by manufacturer.

Vendor Information (VI):

Manufacturer's written instructions for shipping, handling, storage, protection and erection or installation of building and components.

Manufacturer's certification or proof of current membership in Metal Building Manufacturer's Association (MBMA).

Manufacturer's Certificate of Proper Installation.

Operations and maintenance manual.

QUALIFICATIONS:

Provide prefabricated metal buildings as produced by a manufacturer who is regularly engaged in fabrication of pre-engineered metal structures of type and quality indicated. All components shall be provided from one manufacturer.

WARRANTIES:

Warranty shall begin at the time of Substantial Completion.

The roofing and siding shall be warranted for a minimum of ~~20~~5 years against wind damage, leakage, paint fade, chipping, peeling, attachment and rusting. Warranty shall include labor and materials for replacement of defective panels. Warranty shall not be pro-rated over ~~20~~5-year period.

Finish on metal roof and wall panels, flashing, and trim will not chalk, crack, check, blister, peel, flake, chip, or loose adhesion shall be warrantied for 5 years.

PART 2--PRODUCTS

MANUFACTURER:

Dimensions of the 12-foot by 12-foot buildings are based on Panl-Line Building System as manufactured by Butler Manufacturing Co. Dimension and sizes of the 21-foot by 16-foot buildings are based on the Parkline Building Systems, Inc. (Type AL), and VP Buildings, Inc. If an "or equal" building manufacturer is submitted and approved by the Engineer, all dimensions and clearances shall be taken as minimums for evaluation of submittal. Construction Subcontractor shall be responsible for all adjustments required to plans as a consequence of changing building manufacturer. All shop drawings and special process procedures as welding, painting and structural bolting, shall be submitted for approval and shall be stamped by a registered professional engineer licensed to practice in the State of Washington.

Type: The metal building shall be a prefabricated, weather-tight, free-standing building having a structural steel frame. The 12-foot by 12-foot buildings shall be self-framing buildings incorporating diagonal bracing. The 21-foot by 16-foot buildings shall be rigid frame in all walls with no diagonal bracing in the wall. The roof slope and the eave height shall be at as specified on Construction Drawings.

DESIGN LOADS:

The building shall be designed for the following applied loads in addition to dead load:

Roof Live Loads: Roof covering shall be designed for 20 psf uniformly distributed load.

Roof Snow Load: Ground snow load is 15 psf, $C_e = 10$, $I = 0.8$ designed per ASCE 7.

Wind Loads: The wind load on the structure shall be designed per ASCE 7 and DOE STD-1020-02 using a 3-second gust wind velocity of 85-mph wind speed. Design and calculate according to the ASCE 7 exposure Class "C" with an Importance Factor = 1.0.

Seismic Loads: Seismic loads shall be determined and applied in accordance with the UBC Zone 2B, Importance Factor = 1.0, Soil S_c. Out-of-plane system stability, nonstructural components, and equipment shall be evaluated using UBC 1632.

Collateral Loads: All additional dead loads, other than the weight of the metal building system, such as fire sprinklers, mechanical HVAC systems, electrical systems, and ceilings. Collateral loads shall be a minimum of 10 pounds per square foot as defined in the Metal Building Systems Manual published by the MBMA.

Maximum Deflection: Deflection shall be limited to L/240 for DL and DL+LL for all building components.

Combination of Loads: Combined loads shall be as prescribed in the UBC.

Building Code Requirement: Design building, roof system, roof overhang including support framing, roof and wall panels, and fasteners for horizontal and uplift wind loads and earthquake forces.

MATERIALS:

Hot-Rolled Structural Shapes: Conform to ASTM A36 or A529.

Tubing or Pipe: Conform to ASTM A500, Grade B; ASTM A501, or ASTM A53.

Members Fabricated from Plate or Bar Stock: 42,000 psi minimum yield strength; Conform to ASTM A529, A570, or A572.

Members Fabricated by Cold Forming: Conform to ASTM A607, Grade 50.

Galvanized Steel Sheet: Conform to ASTM A446 with G90 coating. "Class" to suit building manufacturer's standards.

STRUCTURAL FRAMING COMPONENTS:

Rigid Frames:

Rigid frames shall be hot-rolled structural steel, factory welded, and shop painted. Furnish complete with attachment plates, bearing plates, and splice members. Factory drilled for bolted field assembly.

Length of span and spacing of frames shall be as shown on Drawings except slight roof slope variations are acceptable to meet manufacturer's standard.

Wind Bracing: No "x" type rod bracing shall be used in bays where bracing would cross windows or door openings, or where the interior of the exterior walls are to be finished. Use portal frames where bracing is required at window or door openings.

Secondary Framing: Purlins, eave girts, girts, flange and sag bracings shall be "Z" or "C" roll formed sections no pre-punched for fasteners, and shall be shop prime painted. Roof purlins shall be spaced a maximum of 5-foot 0-inch O.C. Base channel, sill angle, purlin spacers; minimum 14-gauge cold-formed steel; and shall be shop prime painted.

Anchor Bolts: The anchor bolts for the rigid frames shall be carbon steel and designed by the pre-engineered building manufacturer. Location and placement shall be coordinated with the foundation rebar shown on the Drawings. Any changes in rebar placement shall be brought to the attention of the Construction Subcontractor and engineering calculations shall be provided taking into account the changed rebar location.

Bolts: Bolts shall be ASTM A325 in quantities necessary for design loads and connection details. Provide zinc- or cadmium-plated units when in direct contact with panels. Direct tension indicators shall conform to ASTM F959.

Fabrication:

Shop fabricate to the indicated size and section, complete with base plates, bearing plates, and other plates as required for erection, welded in place, and with all required holes for anchoring or connections shop drilled or punched to template dimensions.

Shop connections shall be power riveted, bolted, or welded.

Field connections shall be bolted. Install high strength threaded fasteners in accordance with "Specifications for Structural Joints Using ASTM A325 or A490 Bolts."

Weld Construction:

Comply with AWS D1.1 for procedures, appearance and quality of welds, and methods used in connecting welding work. Welding shall not be performed at the project site.

Construction General Contractor shall provide Certified Weld Inspector (CWI) to perform visual examination of all off-site welds in accordance with AWS D1.1, Section 6. Document weld acceptance on Construction Subcontractor Weld History.

Shop Painting:

Surfaces to be primed shall be cleaned of loose mill scale, rust, dirt, oil, grease, and other matter precluding paint bond. Follow procedures of SSPC-SP3 for power tool cleaning, SSPC-SP7 for brush-off blast cleaning, and SSCP-SP1 for solvent cleaning.

Prime structural steel primary and secondary framing members with manufacturer's standard rust-inhibitive primer having over 50 percent rust-inhibitive pigment, such as organic zinc. No lead or chromate will be allowed.

Prime galvanized members, after phosphoric acid pretreatment, with zinc dust-zinc oxide primer.

<u>ROOFING AND SIDING:</u>

<u>General:</u> Provide roofing and siding sheets formed to general profile or configuration as specified. Provide flashings, closers, fillers, ridge covers, and other sheet metal accessories, factory formed of same material and finish as roofing and siding. Factory-applied baked enamel, in color selected by the Engineer.

<u>Roof Panels:</u>

The Interlocking-Standing Seam Roof Covering shall carry an Underwriters' Laboratories, Inc., Uplift Classification of not less than Class 90 and shall consist of material not less than 24-gauge aluminized coated steel with Kynar finish on exterior face. The panels shall be installed with the ribs upstanding and parallel to the roof slope.

All longitudinal interlocking ribs as well as any transverse end laps shall be properly sealed, according to the manufacturer's instructions, with non-drying sealant.

The roof panels shall be secured to each structural support by a steel clip concealed between the adjacent male and female ribs and fastened under that panel's weather surface. Clip shall be long enough to allow Styrofoam thermal spacer on top of purlin.

Penetrations through the roof panel by fasteners shall be limited to only those required at the rake eaves, at end laps and at the ridge. All exposed fasteners shall be fitted with weather-seal washers of hydrocarbon-based elastomer (synthetic rubber) with a compatible metal backing.

Thermal (break) spacers shall be provided continuously at each structural support to minimize thermal conductivity. The thermal spacer shall be a continuous Styrofoam strip, 3 inches by 1 inch thick.

<u>Wall Panels Exterior:</u>

The interlocking-ribbed wall covering shall consist of panels of not less than 24 U.S. gauge, fluoropolymer enamel finished, aluminized coated steel with male and female ribs. The wall panels shall be applied to the structural framing with the interlocking ribs toward the interior of the structure. The interlocking ribs shall be secured at the base, at each intermediate girt, and at the support at which it terminates, by means of concealed fasteners, thus eliminating any through-wall fastening. Trim finish to match wall panel.

All interior fasteners, i.e., screws, bolts and nuts, etc., shall be of carbon steel having a protective coating of either zinc or cadmium.

Interior Liner Panels: Interior wall liner panels shall be provided throughout the building on all perimeter walls. The panels shall be 24 gauge, white with concealed fasteners. All panel joints shall be provided with sealer along the edges of each panel. The liner panels shall function as a vapor barrier. Length of panels shall be full height with no horizontal joints. finish shall be as described below.

Sealing Tape: Sealing tape shall be 100 percent solids, pressure sensitive grey polyisobutylene compound tape with release paper backing. Not less than 1/2 inch wide and 1/4 inch thick, nonsag, nontoxic, nonstaining and permanently elastic.

Joint Sealant: Joint sealant shall be one-part elastomeric; polyurethane, polysulfide, or silicon rubber as recommended by building manufacturer.

Ice Stops: Provide ice stops to prevent snow and ice damage to gutters. Ice stops shall be "ICEJAX" as manufactured by Snowjax Inc., Mechanicsburg, Pennsylvania, or approved equal. "ICEJAX" shall be adhered with Loctite "Depend", or approved equal, to metal roof panels.

Rain Gutter and Downspouts: The rain gutter shall be continuous along the eaves of the building. The gutter shall be a surface mounted type with downspout size and number as called for by the building manufacturer or as shown on the drawings. Gutter shall be minimum 5 x 5 inches in cross section. Gutter and downspouts shall be standard design as manufactured by Metal Building Manufacturer, or approved equal. Gutter shall be installed with 1/4 inch per 10-foot 0-inch slope to downspout. Factory finish to match wall panels.

INSULATION AND VAPOR RETARDER:

As specified in Section 07210, BUILDING INSULATION.

DOORS:

Steel Doors: 1-3/4-inch doors, conforming to ANSI/SDI 100, with manufacturer's standard. Provide exterior doors with top and bottom edges finished flush. Provide doors of materials and ANSI/SDI 100 grades and models specified below, or as indicated on drawings and schedules.

Exterior Doors: Unless otherwise indicated, Grade III, extra heavy duty, Model 2 (seamless) design), minimum 16 gauge galvanized steel sheet faces.

DOOR FRAMES:

Provide metal frames for doors and other openings according to ANSI/SDI 100 and of types and styles as shown on drawings and schedules. Conceal fastenings unless otherwise indicated. Frames shall be No. 14 USS gage or heavier cold-rolled steel sheet. Form exterior frames of hot dip galvanized steel. Fabricate frames with mitered and welded corners.

Available manufacturers of steel doors include the following:

AMWELD Building Products Div.

Ceco Corp.

Curries

Fenestra

Republic Builders Products Corp.

Steelcraft Mfg. Co.

Thermal-Rated (Insulating) Assemblies: At all exterior locations, provide doors which have been fabricated as thermal insulating door and frame assemblies and tested in accordance with ASTM C 236 or ASTM C 976. Unless otherwise indicated, provide assemblies with maximum apparent U factor for thermal-rated assemblies is 0.24 Btu/hr (ft^2) degrees F.

HEATING, VENTILATING, AND AIR CONDITIONING SYSTEM:

As specified in Section 15500, HEATING, VENTILATING, AND AIR CONDITIONING SYSTEM.

FIXED LOUVERS:

Material: Factory finish to match wall panels.

Free Airflow: Minimum 50 percent.

Weather Projection: Drainage-type louver.

Insect Screen: Manufacturer's standard 14-Ga to 18-Ga galvanized steel wire mesh screen.

PIPE PENETRATIONS:

For pipe penetrations through the roof use a "DEKTITE" pipe flashing unit as manufactured by ITW Buildex, or approved equal. Provide a stainless steel hose clamp for positive sealing of flashing to pipe.

WALL PENETRATIONS:

Provide opening as required by HVAC air conditioning manufacturer.

ELECTRICAL AND LIGHTING:

As specified in Section 16005, ELECTRICAL.

PART 3--EXECUTION

ERECTION:

Framing: Erect structural framing true to line, level and plumb, rigid and secure. Level base plates to a true even plane with full bearing to supporting structures, set with double-nutted anchor bolts. Use a non-shrinking grout as specified in Section 03301, CONCRETE, to obtain uniform bearing and to maintain a level base line elevation. Moist cure grout for not less than 7 days after placement.

Bracing:

Install diagonal rod or angle bracing in roof as required.

Diagonal/rod bracing shall not interfere with ceiling purlins.

Install portal frame bracing in sidewalls as specified.

Framed Openings: Provide shapes of proper design and size to reinforce opening and to carry loads and vibrations imposed, including equipment furnished under mechanical or electrical work. Securely attach to building structural frame.

ROOFING AND SIDING:

General:

Install panels and associated items for neat and weather tight enclosure. Avoid "panel creep" or application not true to line. Protect factory finish from damage.

Provide weather seal under ridge cap. Flash and seal roof panels at eave, swaged joints and rake with manufacturer's standard rubber, neoprene, or other closures to exclude weather.

Roof Sheets:

Provide sealant tape at lapped joints of ribbed or fluted roof sheets, and between roof sheeting and accessories.

Apply sealant tape continuous to clean, dry surface of weather side of fastenings on end laps and on sidelaps of corrugated or nesting type, ribbed or fluted panels and elsewhere to make weatherproof to driving rains.

Wall Sheets:

Apply elastomeric sealant continuous between metal base channel (sill angle) and concrete foundation and elsewhere as necessary for waterproofing. Handle and apply sealant and backup in accordance with sealant manufacturer's recommendations.

Align bottoms of wall panels. Fasten flashings, trim around openings, etc., with self-tapping screws.

Provide small quantities of paint material and touch-up coatings damaged during construction in accordance with the manufacturer's direction.

Sheet Metal Accessories: Install louvers and other sheet metal accessories in accordance with manufacturer's recommendations for positive anchorage to building and weathertight mounting.

Interior Wall Liner Panels: Install all wall liner panels as shown on the Drawings.

Certification: The Construction Subcontractor shall submit a certified statement that all standing seam metal roofing, flashings, rain gutter and downspout, wall panels, structural framing, and anchor bolts have been installed in strict accordance with the manufacturer's printed instructions and this specification.

Door Installation: Fit hollow metal doors accurately in frames, within clearance specified in SDI-100.

HARDWARE SCHEDULE:

Group No. 2:

Butts: 1-1/2 pair Mckinney T4A3386 4.5 x 4.5 x BHMA 630.

Lockset: 1 Best 84-7-C-15D-S3 x BHMA 626.

Closer: 1 LCN P4041 x BHMA 673.

Rain Drip: 1 Pemko 346C.

Kick Plate: 1 SST–10 inches high by 0.05 inch thick.

Weatherstripping: 1 set Pemko 319CN x S88 x BHMA 628.

Door Bottom: 1 Pemko 430CRL x BHMA 628.

Threshold: 1 Pemko 254X4AFG x BHMA 628.

CONSTRUCTION QUALITY CONTROL:

High Strength Bolted Connections: Construction General Contractor shall provide special inspections to verify field connections with high strength bolts are installed in accordance with plans and specifications and AISC requirements.

END OF SECTION 13122

SECTION 13205--LINED BOLTED STEEL LIQUID STORAGE TANKS

PART 1--GENERAL

REFERENCES:

The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designations only.

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA D103	Factory-Coated Bolted Steel Tanks for Water Storage
AWWA D130	Flexible-Membrane-Lining and Floating-Cover Materials for Potable Water Storage

ASTM INTERNATIONAL (ASTM)

ASTM A446	Steel Sheet, Zinc-Coated by the Hot-Dip Process, Structural Quality
ASTM A525	General Requirements for Steel Sheet, Zinc-Coated by the Hot-Dip Process
ASTM D413	Standard Test Methods for Rubber Property-Adhesion to Flexible Substrate
ASTM D751	Standard Test Method for Coated Fabrics

FEDERAL STANDARDS (FS)

FS 5100	Preservation and Packing of Hand Tools; Tools and Tool Accessories for Power-Driven Metal Woodworking Machinery

INTERNATIONAL CONFERENCE OF BUILDING OFFICIALS

UBC	Uniform Building Code

DESCRIPTION:

This Specification sets the minimum standards for design and construction of two lined, bolted liquid storage tanks. The tanks shall be constructed from corrugated galvanized steel panels bolted together such that no field welding or onsite coating is required. The system shall provide an interior geosynthetic fabric to protect the factory fabricated membrane liner. A tank primary and secondary liner system shall be utilized.

QUALIFICATIONS:

Tank Manufacturer: At least five tanks presently in service, of similar size and character required for this Project, and minimum of 5 years' satisfactory operation.

Tank Installer: Certified by tank manufacturer that installer is qualified to do the Work.

Registered Professional Engineer: Licensed in the state of Project with training and expertise in tank system design and installation. Able to recognize signs of potential tank system failure during the intended operating life of the tank. Able to assess and interpret information on the waste to be stored in the tank and the waste compatibility with the materials used for the tank and piping system.

Installation Inspector: Knowledge of the physical sciences and the principals of engineering acquired by a professional education and related practical experience. Trained and experienced in the proper installation of tank systems or components. Certified by tank manufacturer that the inspector is qualified and experienced in type of Work to be performed.

SUBMITTALS–APPROVAL REQUIRED:

See Section 01300, SUBMITTALS, for submittal procedures.

Statements of Qualifications:

Tank manufacturer.

Tank installer.

Registered professional engineer.

Installation inspector.

Tank Secondary and Primary Liners and Floating Cover:

Material Samples: Within 15 days from Notice to Proceed: Samples of the materials proposed for use. Submit fifty (50) sample coupons, each 8 inches by 10 inches in size, for use by the Engineer to conduct leachate compatibility testing.

Manufacturer's Data: Manufacturer's descriptive data, specifications sheets, literature, and other data as necessary to fully demonstrate that those materials proposed for use comply with the requirements of these Specifications.

Installation Plan: Submit an installation plan for the liners and cover describing the proposed methods for liner and cover deployment, panel layout, seaming, repair, and protection. The plan shall also include a quality control program for the Construction General Contractor's activities related to liner and cover materials installation.

Factory Fabrication Inspection Data (Source Quality Control): Submit documentation of factory inspection as specified herein.

Drawings:

Tank and Equipment: Detailed drawings for tanks, anchor bolts and anchor bolt chains, and equipment, such as wall construction, pipe connections, floating cover, floating cover water removal system, secondary containment system, and stilling wells for installation of level controls shall be stamped by the Registered Professional Engineer. Level controls are provided by others (see Section 13401, PICS). Drawings shall include a complete list of equipment and materials, including manufacturer's descriptive and technical literature, and installation instructions.

Calculations:

Stamped by the Registered Professional Engineer. Complete structural stress analysis of structural components and connections and anchorage system to the concrete ringwall. Include anchor bolt reaction for all load cases and load combinations.

Design Assessment Report:

A written report providing the results of the tank system design assessment prepared and certified by the Registered Professional Engineer attesting that the tanks furnished under this section of the Specifications has sufficient structural integrity and is acceptable for the storing and treating of dangerous waste.

The assessment report shall contain the following:

Site map of the facility showing the proposed location of the tank system within the overall facility.

A sketch of the tank system including connected piping and fittings. Individual tanks shall be clearly labeled.

Structural design standards and criteria used with reference to applicable industry standards and recommended practice codes. Include all calculations for tanks and anchoring. Tank shell shall be designed based on full tank. Design parameters used in calculations shall be clearly indicated and labeled on clarifying sketches. Seismic considerations that are appropriate to the seismic risk zone shall be accounted for in the calculations.

Assessment of the compatibility of the leachate to be stored in the tank with the tank system materials. Show that the characteristics of the leachate to be stored are compatible with the material properties of the tank system, including material properties of the interior lining. Include the results of the chemical compatibility testing provided by the Engineer in this assessment.

Description and assessment of the secondary containment system, results of primary liner and secondary liner leak detection surveys, ~~including prevention of migration of leachate out of the secondary containment system; detection~~ and collection of releases into the secondary containment system; compatibility of the materials in the secondary containment system with the leachate to be stored in the tank; strength of secondary containment system to withstand stresses from static head during a release, climatic conditions, nearby vehicle traffic, and daily operations; description of the leak detection system that will detect the failure of ~~either~~ the primary ~~or secondary~~ containment structure or the presence of any release of leachate or accumulated liquid in the secondary containment system within 24 hours; a description of the corrosion protection for the exterior surface of the tank.

Assessment of ~~the design of any~~ ancillary equipment as shown on the Drawings (piping, fittings, flanges, valves, and pumps) associated with the tank including support and protection against damage and excessive stress due to excessive settlement, vibration, expansion, or contraction. Verify that peak flows and internal stresses are within the design limits specified by the manufacturer of the ancillary equipment.

The recommended inspection schedule once the tank is placed in service based on the performance of similarly designed tank systems operating under similar conditions.

A statement by the Registered Professional Engineer certifying that the tank system has been adequately designed and that the tank system has sufficient structural strength to ensure that it will not collapse, rupture, or fail under the design conditions. The certification shall include the following statement:

> "I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

The Registered Professional Engineer's signature and stamp must be placed below the certification statement.

SUBMITTALS–APPROVAL NOT REQUIRED:

Vendor Information (VI):

Installation: Tank Installation Instructions.

O&M Manual:

Tank Materials ~~and Level Indicator~~: Submit operating and maintenance instructions prior to completion of the Project. The manual shall include the manufacturer's cut sheets, parts lists, and a brief description of all equipment and their operating features. Maintenance instructions shall include all routine maintenance procedures, possible breakdowns and repairs, and trouble shooting guiding. ~~As-built diagrams of the piping system including valve locations shall be submitted with the O&M manual.~~

Information/Record (IR):

Submit documentation of construction quality control as specified herein.

Installation Inspection Report: A written report prepared by the Installation Inspector or the Registered Professional Engineer documenting the results of the tank system installation inspection. The installation inspection report shall contain the following:

The as-built site plan showing the location of the installed tank system.

An as-built drawing of the installed tank system including connected piping. Individual tanks shall be clearly labeled with ID numbers.

Inspection notes, photographs, and any other material used to document inspection activities.

An assessment of the tank system for structural damage or inadequate construction/installation including weld breaks, punctures, damage to protective coatings, cracks, and corrosion, and documentation of any defects discovered in materials, equipment, or installation procedures and measurements taken to correct these defects.

Documentation of tightness testing results demonstrating the tank system is tight prior to placing it in service.

A statement certifying the proper installation of the tank system liner, signed by the liner installer's representative.

A signed and dated statement by the Installation Inspector or Registered Professional Engineer certifying the proper installation of the tank system. The certification shall include the following statement:

> "I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

LEACHATE COMPATIBILITY TESTING:

The Engineer will conduct leachate compatibility testing on the tank liner and cover material samples submitted by the Construction General Contractor in accordance with EPA SW 846, Method 9090, or ASTM D5322 and D5747 procedures. At the completion of the testing, the Engineer will evaluate the testing data for conformance with the project requirements and approve or reject the material. The Engineer will provide the results of the evaluation and approval or rejection to the Construction General Contractor within 180 days after receipt of material samples. Construction General Contractor shall not order materials or proceed with fabrication until after receiving results and approval from the Engineer. Any product or material changes required as a result of inadequate leachate compatibility results will be addressed by Change Order, provided that the submitted material meets all other requirements of this section.

DELIVERY AND STORAGE:

All materials and equipment delivered and placed in storage shall be stored with protection from the weather, excessive humidity, and excessive temperature variation; and dirt, dust, or other contaminants. The tank components shall be shipped in crate(s) or pallet(s) designed to prevent physical damage to the tank coating, linings, and structural components.

WARRANTY:

The tank shall have a 3-year warranty from the date of Substantial Completion covering workmanship, materials, all steel components, and the liners and floating cover system. The warranty shall provide for correction, or, at the option of the Tank Farm Contractor, removal and replacement of Work specified in this Specification section found defective during the period of the warranty.

The Construction General Contractor shall provide the manufacturer's written warranty for the liners and cover. The warranty shall be provided to the Construction General Contractor as purchaser with the Tank Farm Contractor named as beneficiary and shall be signed by an authorized representative of the liner and cover manufacturer. The warranty shall guaranty the liner and cover material for the above-stated period against:

Manufacturing defects.

Deterioration due to ozone, ultraviolet, and other exposure to the elements, including the stored leachate.

Defects in material and factory seams.

Defects resulting from installation.

PART 2--PRODUCTS

MANUFACTURER:

Dimensions are based on bolted steel tank as manufactured by Environetics, Inc. All dimensions and clearances shall be taken as minimum if an "or equal" tank manufacturer is submitted and approved by the Engineer. Construction General Contractor shall be responsible for all adjustments required to Drawings as a consequence of changing tank manufacturer.

STANDARD PRODUCTS:

Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of such products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment shall be supported by a service organization that is, in the opinion of the Engineer, reasonably convenient to the site. The items specified under this section shall be furnished by constructors having experience and regular practice in the design, fabrication, and construction of steel tanks.

TANK SIZE REQUIREMENTS:

Number of Tanks Required: Two.

Required Diameter: 101.46 feet.

Required Height: 8.17 feet.

Cover Required: Yes.

Leachate Volume: 375,000 gallons.

Top Capacity Level (TCL): 6.20 feet above tank floor.

DESIGN:

Design shall be in accordance with the requirements of AWWA D103.

Design Loads:

Specific Gravity: The tank shall be designed for liquids with a specific gravity of 1.00.

Earthquake: The tank shall be designed for Seismic Zone 2B per UBC and AWWA D103, site amplification soil profile C, I=1.0. For seismic, use leachate top capacity level (TCL).

Wind Force: The tank shall be designed to the greater requirements of a 100-mph wind with pressure loads as calculated with AWWA D103 or an 85-mph with pressure loads determined using ASCE 7, 1998. Wind force calculations shall include wind analysis with an empty tank case as well as a full tank case.

Hydrostatic Pressure: Design tank for static pressure to top of tank shell height.

Stored Leachate Characteristics:

Based on previous testing, the stored leachate is expected to have the following characteristics:

Chemical Compound	Concentration (g/l)
$NaNO_3$	185.0
Na_2SO_4	11.86
NaF	1.46
Na_2CO_3	3.45
$NaHCO_3$	2.44
pH	9.2 ± 0.1, using NaOH or HNO_3 as required

TANK COMPONENTS:

The tank and liner system shall consist of the following components: Corrugated steel wall panels with anchor embedded in concrete ringwall, geotextile base and wall buffer, secondary containment liner, drainage net, primary liner and floating cover, pipe connections, tank ladder, and piping for level and leak detection measurement.

Corrugated Steel Wall Panels:

The tank walls shall be constructed from individual rings of corrugated, hot-dip galvanized steel, mill-rolled to finished diameter. Sheet materials shall be

ASTM A446, Grade D; or equal. Sheet materials shall be mill galvanized to ASTM A525, Class G90 standards, or equal. Shell plate thickness shall be based on AWWA D103 structural requirements. Wall plate thickness shall be a minimum of 12 gauge. Provide wind stiffeners as required by design.

Sheet materials shall receive an electrostatically applied, thermally cured, polyester powdercoat finish. The coating shall be applied in two coats with a minimum dry film thickness of 5.0 mils. The finished coating shall be white in color.

Anchor Bolts: Shall conform to the requirements of AWWA D103.

Bolted Joints: Structural bolts conform to the requirements of AWWA D103 and shall be zinc electroplated. Bolted joints shall utilize a minimum two vertical rows as required to withstand structural loads.

Geotextile Base and Wall Buffer: An 8-ounce geotextile polypropylene nonwoven needle-punched fabric shall be placed on the tank floor and wall as a buffer for the liner. The fabric shall be designed to protect the liner from irregular surfaces on the tank wall. The material properties shall conform with the following:

Fabric Property	Unit	Test Method	Value
Grab Tensile Strength	lb	ASTM D4632	203
Grab Elongation	%	ASTM D4632	50
Puncture Strength	lb	ASTM D4833	130
Mullen Burst	psi	ASTM D3786	400
Trapezoid Tear Strength	lb	ASTM D4533	80

Fabric Property	Unit	Test Method	Value
Permittivity	sec^{-1}	ASTM D4491	1.5
Water Flow Rate	gpm/sq ft	ASTM D4491	110
AOS	sieve	ASTM D4751	100
UV Resistance	% strength @ 500 hrs	ASTM D4355	70

Tank Secondary and Primary Liners and Floating Cover:

The liners and floating cover shall be fabricated from polyester reinforced polymeric alloy. Sheet materials shall have UV resistance and weathering qualities and conform to the following properties:

Physical Property	Physical Values	Test Method
Thickness	30.0 mils min.	ASTM D751
Weight	30.0 ± 2 oz/yd^2	ASTM D751
Tear Strength	35/35 lb$_f$ min.	ASTM D4533, Trapezoid Tear
Breaking Yield Strength	550/550 lb$_f$ min.	ASTM D751, Grab Tensile
Low Temperature	Pass @ -30°F	ASTM D2136, 4 hr – 1/8" mandrel
Dimensional Stability	1.5% max. each direction	ASTM D1204, 212°F – 1 hr
Adhesion - Heat Sealed Seam	35 lb$_f$/2 in min.	ASTM D751, Dielectric Weld
Dead Load - Seam Shear Strength	2 in seam, 4 hr, 1 in strip 210 lb$_f$ @ 70°F 105 lb$_f$ @ 160°F	ASTM D751
Bursting Strength	650 lb$_f$ min. 800 lb$_f$ typical	ASTM D751 Ball Tip
Hydrostatic Resistance	800 psi min.	ASTM D751, Method A
Blocking Resistance	# 2 Rating max.	ASTM D751 (180°F/82°C)
Adhesion - Ply	15 lb$_f$/in min. or Film Tearing Bond	ASTM D413
Bonded Seam Strength	550 lb$_f$ min.	ASTM D751 as modified by NSF 54
Abrasion Resistance	2,000 cycles (min.) before fabric exposure 50 mg/100 cycles max weight loss	ASTM D3389 (H-18 Wheel, 1,000 g load)

Physical Property	Physical Values	Test Method
Weathering Resistance	8,000 hrs (min.) – No appreciable changes or stiffening or cracking of coating	ASTM G23 (Carbon-Arc)
Water Absorption	0.025 kg/m2 max. @ 70°F/21°C 0.14 kg/m2 max. @ 212°F/100°C	ASTM D471, Section 12, 7 days
Wicking Shelter-Rite® Procedure	1/8 in max.	
Puncture Resistance	250 lbf min.	ASTM D4833
Coefficient of Thermal Expansion/Contraction	8×10^{-6} in/in/°F max.	ASTM D696

Secondary and Primary Tank Liners: Shall be fabricated in a controlled factory environment into complete liners or large prefabricated panels. Size shall be limited to 3,000 pounds for ease of installation.

Tank Liner Source Quality Control: The tank liner(s) and cover shall be fabricated from standard width sheeting into a full-size fitted liner by means of minimum 1-inch wide dielectric and 2-inch wide thermal welds. The liner(s) and cover shall be thoroughly inspected by the fabricator for flaws in materials or fabrication prior to shipment. Inspection shall be performed by 100 percent visual inspection and proprietary inflation-light test methods. Construction General Contractor shall provide documentation of factory inspections to the Construction Manager.

Floating Cover: The cover shall be designed to comply with applicable AWWA D130 ~~D103~~ design standards. The cover shall incorporate closed cell polyethylene foam floatation elements in cover membrane pockets to provide the required buoyancy, drainage, and wind stability. The cover shall incorporate ~~center and perimeter vents~~ a center vent to evacuate air during fill cycle. The manufacturers shall provide a pump system with pump to remove excess surface water. Floating cover shall drain towards the perimeter of the tank ~~and pump~~ where excess water may be collected and pumped out. Cover vent shall include a base plate to prevent tipping due to wind or snow load.

Drainage Net: The floor area of the tank shall be covered with fitted panels of high density polyethylene (HDPE) drainage net with a geotextile laminated to both sides of the drainage net to prevent clogging and to provide a cushion for the HDPE drainage net against the tank liners. The drainage net shall be installed between the primary and secondary liners to convey liquids between the liners to a leak detection sump. Properties for the drainage net and geotextile are as follows:

Physical Properties	Test Method	Physical Value
Combined:		
Transmissivity, m/sec	ASTM D4716	4×10^{-5}
Drainage Net Component:		
Transmissivity, m/sec	ASTM D4716	1×10^{-3}
Thickness, mill	ASTM D1777	200
Density g/cm^3	ASTM D105	0.94
Tensile Strength, lb/in	ASTM D5034/5035	45
Carbon Black Content, %	ASTM D1603	2.0
Geotextile Component:		8 oz/yd^2
Thickness, mill	ASTM D5199	90
Grab Tensile, lb	ASTM D4632	210
Puncture Strength, lb	ASTM D4833	135
AOS, US Sieve	ASTM D4751	80
Flow Rate, gpm/ft	ASTM D4491	110
UV Resistance, % retained	ASTM D4355	70

Pipe Connections: Pipe fittings and connections shall be in accordance with manufacturer's requirements for double containment connections. Location of pipe connections shall be as shown on the Drawings.

Tank Ladder: Provide a hot-dipped galvanized steel ladder for access to the floating cover pump. The ladder shall be attached at the top of the tank wall and at its base to the concrete ringwall. The ladder shall be of sufficient height to allow viewing of the floating cover system and its pump. The ladder shall be located adjacent to the tank level element installation.

Tank Level and Leak Detection Measurement:

Provide as part of tank construction two 2-inch diameter (Schedule 80 PVC) internal slotted level sensor pipes (stilling wells) that extend the whole interior operating height of tank, for the purpose of facilitating the installation of a submersible pressure transmitter (in one pipe), and a multipoint level sensor (in the other pipe). Level measurement instrumentation provided under Section 13401, PROCESS INSTRUMENTATION AND CONTROL SYSTEMS (PICS), and installed by Construction General Contractor under this section.

Construction General Contractor shall furnish and install all necessary equipment and personnel to properly support installation of measurement devices (i.e., PVC flanges, straps, and gaskets).

Foundation: Tank shell to bear on a Type 1 concrete ringwall per AWWA D103 as shown on the Drawings. A 1-1/2-inch minimum space between the tank bottom and the top of the ringwall shall be filled with a nonshrink grout as specified in Section 03301, CONCRETE. Cane fiber joint filler shall not be used. Ringwall design is shown on Drawings.

PART 3--EXECUTION

GENERAL:

Tank construction shall be in accordance with AWWA D103.

TANK INSTALLATION:

Field erection of lined bolted steel tanks, including, but not limited to, shell plates, pipe connections, awning, primary and secondary containment, and floating cover, shall be in strict accordance with the manufacturer's recommendations including their guidance on environmental factors that could affect the tank installation.

CONSTRUCTION QUALITY CONTROL:

The Construction General Contractor shall establish and maintain a quality control system to assure compliance with contract requirements and shall maintain records of its quality control for all operations including, but not limited to the following:

Inspection of materials delivered to project site against approved material data.

Storage and handling of materials.

Finished appearance.

Completion of required testing.

Copies in duplicate of these records and tests, as well as records of corrective action taken when results are unsatisfactory, shall be furnished to the Construction Manager within 24 hours following the inspection or test.

Tank System Installation Inspection:

The Construction General Contractor shall provide the services of an Installation Inspector or Registered Professional Engineer to provide full-time supervision of the installation of the storage tanks. No work shall be performed without the presence in the field of the Installation Inspector or Registered Professional Engineer. The

Installation Inspector or Registered Professional Engineer shall observe and verify that correct materials and procedures are used for the following activities:

Visual inspection and testing.

Subgrade and foundation preparation.

Placement and compaction of backfill.

Placement of reinforcing steel and anchor bolts.

Concrete placement.

Placement of shop-fabricated tank parts.

Erection of field-erected tank parts.

Installation of tank liner systems. Tank liner inspection requirements are specified herein.

Installation of piping, pumping, and other ancillary equipment.

Tightness testing.

Tank Liner Inspection:

Visual Inspection: 100 percent visual inspection along all seams of the liners.

Air Jet Inspection: 100 percent air jet inspection of all seams.

Any required repairs shall be corrected in accordance with the manufacturer's recommendations. Results of all testing shall be provided to the Construction Manager.

Electronic Leak Location Survey: Prior to installing the floating cover, complete an electronic leak location survey of the secondary and primary liners.

Floating Cover Drainage Test:

Add water on floating cover to test that water drains towards the perimeter. Manufacturer to revise ballast if water does not completely drain.

Tank Tightness Testing:

Upon completion of tank installation, the tank shall be visually inspected for any signs of physical damage. Any questionable areas shall be repaired in accordance with the manufacturer's instructions. The tank shall be filled with water and let stand for a period of not less than 2 days. The Construction General Contractor shall maintain a level not less than 7.2 feet for the duration of 2 days. Following the 2 days, the Construction General Contractor shall cyclically change the tank water level at a constant rate from 0.5 foot to 7.2 feet for four cycles over the next 28 days. During the 30 days, there shall be no signs of leakage to the secondary containment system of the tank. ~~At the end of the 30 days, the tank shall also undergo an electronic leak location survey to check for leakage.~~ Any leaks discovered by this test shall be corrected by the Construction General Contractor in accordance with the manufacturer's recommendations. The tank system shall be successfully tested before it is accepted. Results of all testing shall be provided to the Construction Manager.

END OF SECTION 13205

SECTION 13401--PROCESS INSTRUMENTATION AND CONTROL SYSTEMS (PICS)

PART 1--GENERAL

UL AND NRTL COMPLIANCE:

Materials manufactured within the scope of UL or another nationally recognized testing laboratory (NRTL) shall conform to UL or NRTL standards and have an applied UL or NRTL listing mark. References to UL throughout this section imply conformity with UL or NRTL standards and guidelines.

PICS control panels shall be manufactured, assembled, tested, approved, and clearly labeled in accordance with UL 508A when required, prior to delivery to construction site.

Approval by Authority Having Jurisdiction (AHJ): As specified in Section 16005, ELECTRICAL.

WORK INCLUDES:

Engineering, furnishing, installing, calibrating, adjusting, testing, documenting, starting up, and Tank Farm Contractor training for a complete Process Instrumentation and Control System for plant.

Detailed Design: PICS as shown and specified includes functional and performance requirements and component specifications. Complete detailed PICS design.

Major Cell No. 1 and Cell No. 2 components and controls to integrate into PICS and to program include:

Crest Pad Building Control Panel, PLC, and Operator Interface Assemblies.

Crest Pad Building Sump, Combined Sump, Leachate Tank, and Leachate Transfer Building Transfer Pump Local Control Panel Assemblies.

Leachate Collection and Removal, and Leak Detection System Pump Control.

Leachate Collection and Removal, and Leak Detection System Pump Discharge Flow and Flow Totalization.

Leachate Collection and Removal System Continuous Level Measurement.

Leak Detection System Continuous Level Measurement.

Leachate Storage Tank Continuous Level Measurement.

Leachate Storage Tank, Crest Pad Building Sump, Carrier Pipe, and Combined Sump Leak Detection Chamber Discrete Level Measurement.

Crest Pad Building Sump Discrete Level Measurement, and Pump Control.

Combined Sump Discrete Level Measurement, and Pump Control.

Interlock Control between Crest Pad Building Sump and Leachate Collection, and Removal and Leak Detection System Pump Controls.

Crest Pad and Leachate Transfer Building Continuous Temperature Measurement.

Leachate Transfer Pump Control and Flow Measurement, and Flow Totalization.

Crest Pad Building Discrete Power Measurement.

DEFINITIONS:

Abbreviations:

CAT: Construction Acceptance Test.

CP: Control Panel.

FDT: Factory Demonstration Test.

LCP: Local Control Panel.

MCC: Motor Control Center.

OIU: Operator Interface Unit.

~~ORT: Operational Readiness Testing.~~

~~PAT: Performance Acceptance Test.~~

PCT: PICS Continuity Test.

PFT: PICS Functionality Test.

PLC: Programmable Logic Controller.

SLC: Small Programmable Logic Controller.

Rising/Falling: Terms used to define actions of discrete devices about their set points.

Rising: Contacts change state when an increasing process variable rises through set point.

Falling: Contacts change state when a decreasing process variable falls through set point.

Signal Types:

Analog Signals, Current Type:

4 to 20 mA dc signals conforming to ISA S50.1.

Unless otherwise indicated for specific PICS Subsystem components, use the following ISA 50.1 options:

Transmitter Type: Number 2, two-wire.

Transmitter Load Resistance Capacity: Class L.

Fully isolated transmitters and receivers.

Analog Signals, Voltage Type: 1 to 5 volts dc within control panels only.

Discrete signals, two-state logic signals using dc or 120V ac sources as indicated.

Special Signals: Other types of signals used to transmit analog and digital information between field elements, transmitters, receivers, controllers, and digital devices.

Instrument Tag Numbers: In accordance with DOE-RL Standards.

SUBMITTALS–APPROVAL REQUIRED

See Section 01300, SUBMITTALS, for submittal procedures.

Shop Drawings:

General:

Shop Drawings, full-scaled details, wiring diagrams, catalog cuts, and descriptive literature.

Identify proposed items and options. Identify installed spares and other provisions for future work (e.g., reserved panel space; unused components, wiring, and terminals).

Bill of Materials: List of required equipment.

Group equipment items as follows:

I&C Components: By component identification code.

Other Equipment: By equipment type.

Data Included:

Equipment tag number.

Description.

Manufacturer, complete model number, and all options not defined by model number.

Quantity supplied.

Component identification code where applicable.

Catalog Cuts: I&C Components, Electrical Devices, and Mechanical Devices:

Catalog information, mark to identify proposed items and options.

Descriptive literature.

External power and signal connections.

Scaled drawings showing exterior dimensions and locations of electrical and mechanical interfaces.

Component Data Sheets: Data sheets for I&C components.

Format and Level of Detail: In accordance with ISA-S20.

Include component type identification code and tag number on data sheet.

Specific features and configuration data for each component:

Location or service.

Manufacturer and complete model number.

Size and scale range.

Set points.

Materials of construction.

Options included.

Name, address, and telephone number of manufacturer's local office, representative, distributor, or service facility.

Panel Construction Drawings:

Scale Drawings: Show dimensions and location of panel mounted devices, doors, louvers, and subpanels, internal and external.

Panel Legend: List front of panel devices by tag numbers, nameplate inscriptions, service legends, and annunciator inscriptions.

Bill of Materials: List devices mounted within panel that are not listed in panel legend. Include tag number, description, manufacturer, and model number.

Construction Details: NEMA rating, materials, material thickness, structural stiffeners and brackets, lifting lugs, mounting brackets and tabs, door hinges and latches, and welding and other connection callouts and details.

Construction Notes: Finishes, wire color schemes, wire ratings, wire and terminal block, numbering and labeling scheme.

Panel Control Diagrams: For discrete control and power circuits.

Diagram Type: Ladder diagrams. Include devices, related to discrete functions, that are mounted in or on the panel and that require electrical connections. Show unique rung numbers on left side of each rung.

Item Identification: Identify each item with attributes listed.

Wires: Wire number and color. Cable number if part of multiconductor cable.

Terminals: Location (enclosure number, terminal junction box number, or MCC number), terminal strip number, and terminal block number.

Discrete Components:

Tag number, terminal numbers, and location ("FIELD", enclosure number, or MCC number).

Switching action (open or close on rising or falling process variable), set point value and units, and process variable description (e.g., Sump Level High).

Relay Coils:

Tag number and its function.

On right side of run where coil is located, list contact location by ladder number and sheet number. Underline normally closed contacts.

Relay Contacts: Coil tag number, function, and coil location (ladder rung number and sheet number).

Show each circuit individually. No "typical" diagrams or "typical" wire lists will be permitted.

Ground wires, surge protectors, and connections.

Panel Wiring Diagrams: Show point-to-point and terminal-to-terminal wiring within panel.

Loop Diagrams: Individual wiring diagram for each analog or pulse frequency loop.

Conform to the ~~DOE-RL~~ ISA S5.4 Standards.

Drawing Size: Individual 11-inch by 17-inch sheet for each loop.

Divide each loop diagram into areas for panel face, back-of-panel, and field.

Show:

Terminal numbers, location of dc power supply, and location of common dropping resistors.

Switching contacts in analog loops and output contacts of analog devices. Reference specific control diagrams where functions of these contacts are shown.

Tabular summary on each diagram.

Transmitting Instruments: Output capability.

Receiving Instruments: Input impedance.

Loop Wiring Impedance: Estimate based on wire sizes and lengths shown.

Total loop impedance.

Reserve output capacity.

Conduit and cable schedule names.

Interconnecting Wiring Diagrams:

Diagrams, device designations, and symbols in accordance with NEMA ICS 1.

Diagrams shall bear electrical Construction Subcontractor's signature attesting diagrams have been coordinated with Division 16, ELECTRICAL.

Show:

Electrical connections between equipment, consoles, panels, terminal junction boxes, and field mounted components.

Component and panel terminal board identification numbers, and external wire and cable numbers.

Circuit names matching Conduit and Cable Schedule.

Intermediate terminations between field elements and panels for, e.g., to terminal junction boxes and pull boxes.

Pull boxes.

Factory Demonstration Test (FDT): Provide FDT documentation for control panels.

Installation Details: Include modifications or further details required to adequately define installation of I&C components.

List of spares, expendables, test equipment and tools.

SUBMITTALS–APPROVAL NOT REQUIRED

Information/Record (IR): For PICS equipment, provide Manufacturer's Certificate of Proper Installation and readiness for operation.

Tank Farm Contractor Training Plan: In accordance with Article TRAINING.

Construction Quality Control Test Data: Provide documentation of PICS Continuity Test (PCT) and PICS Functionality Test (PFT).~~Operation Readiness Test (ORT) and Performance Acceptance Test (PAT).~~

Operation and Maintenance (O&M) Manuals:

Content and Format:

Complete sets O&M manuals.

Sufficient detail to allow operation, removal, installation, adjustment, calibration, maintenance and purchasing replacements for each PICS component.

Final versions of Legend and Abbreviation Lists.

Include:

Process and Instrumentation Diagrams: One reproducible copy of revised P&ID to reflect as-built PICS design.

Refer to paragraph Shop Drawings for the following items:

Bill of Materials.

Catalog Cuts.

Component Data Sheets.

Panel Control Diagrams.

Panel Wiring Diagrams, one reproducible copy.

Loop Diagrams, one reproducible copy.

Interconnecting Wiring Diagrams, one reproducible copy.

Device O&M manuals for components, electrical devices, and mechanical devices include:

Operations procedures.

Installation requirements and procedures.

Maintenance requirements and procedures.

Troubleshooting procedures.

Calibration procedures.

Internal schematic and wiring diagrams.

Component Calibration Sheets from field quality control calibrations.

List of spares, expendables, test equipment and tools provided.

List of additional spares, expendables, test equipment and tools recommended.

<u>Factory Demonstration Test (FDT), PICS Continuity Test (PCT), and PICS Functionality Test (PFT) ~~Operational Readiness Test (ORT), and Performance Acceptance Tests (PAT)~~ Submittals:</u>

<u>Preliminary Test Procedures:</u> Outlines of proposed tests, forms, and checklists.

<u>Final Test Procedures:</u> Proposed test procedures, forms, and checklists.

Test Documentation: Copy of signed off test procedures when tests are completed.

Application Software Submittal and Design Workshops:

Location: There shall be a minimum of six (6) workshops held at the Tank Farm Contractor's facility (or by video and audio conferencing) during the course of the project.

Objective: To provide a vehicle by which the Tank Farm Contractor is able review and comment on PLC, OIU, communication hardware, standard software, and application software submittals and application software development.

Documentation: Application software supplier shall summarize resolutions reached in each workshop, including cost and schedule impacts and distribute copies to Tank Farm Contractor.

Order and minimum topics to be covered in each workshop:

Applications Software Design Workshop (kick off) that establishes project processes, including:

Workshop objectives.

Submittal process.

Review Work Sequence and schedule.

Loop Specifications, P&ID Review Workshop:

Application Software Supplier use P&IDs and Specifications to present how the proposed control system design and Applications Software will meet the functional requirements specified herein.

At the completion of workshop Applications Software Supplier modifies as necessary Loop Specifications.

Submit finalized Loop Specification along with an outline of any application software cost and schedule impacts.

PLC Software Standards Submittal Workshop: PLC Software Standards shall be developed in a Software Standards Workshop. Ladder diagram standards for commonly used functions, including the following:

Objective: To develop, implement, and review implementation of PLC Software Standards in ladder logic programming.

Ladder diagram standards for commonly used functions, including the following:

High and low process variable alarm checking.

Instrument failure alarm detection.

Equipment start/stop control.

Equipment failure detection.

Equipment run time.

Leak detection and equipment interlocks.

Signal filtering.

Flow totalization.

Alarm routines.

Interface with OIU.

Memory mapping, data transfer (read/write, remote set point adjustment, pump control and alarm management).

Submit for review ladder logic programming for each PLC including: descriptive ladder logic, cross references, memory map and point databases.

OIU Standard Workshop:

Objective: To develop, implement, and review implementation of OIU standards with Tank Farm Contractor.

Design Products and Topics to be Finalized:

OIU and PLC integration.

OIU tag naming conventions.

Process, set point, and runtime graphics.

Display paging and navigation.

Dynamic Objects: Pumps, valves, gates, compressors, etc.

Equipment control through pop up windows.

General data entry through the OIU.

Dynamic Objects: Pumps, valves, gates, process indicators, indicators with alarms, data entry, controller face plate, and tanks.

Security.

Alarm Management.

Minimum OIU Design Products and Topics to be Finalized for Each OIU:

Eight (8) Process Graphics.

Eight (8) Pop-Up Equipment Operation Control Graphics.

One (1) Alarm Summary Process Control Graphic.

One (1) Alarm History Process Control Graphic.

One (1) Equipment Runtime Process Control Graphic.

One (1) Analog Process Summary Control Graphic.

Submit for review OIU programming and development for each OIU computer including: memory mapping, database structures, graphic displays, and alarms.

DELIVERY, STORAGE, AND HANDLING:

Provide site and warehouse storage facilities for PICS equipment.

Prior to shipment, include corrosive-inhibitive vapor capsules in shipping containers, and related equipment as recommended by the capsule manufacturer.

Prior to installation, store items in dry indoor locations. Provide heating in storage areas for items subject to corrosion under damp conditions.

Cover panels and other elements that are exposed to dusty construction environments.

Electrical equipment (valves, instruments, sensors, enclosures) shall be wired complete and in accordance with the manufacturer's wiring diagrams and instructions.

Completed wiring diagrams shall be incorporated in the O&M submittal.

ENVIRONMENTAL REQUIREMENTS:

Standard Environmental Requirements: Unless otherwise noted, provide equipment for continuous operation in these environments:

Freestanding Panel and Consoles:

Inside: NEMA 12.

Smaller Panels and Assemblies (that are not Freestanding):

Inside: NEMA 4X.

All Other Locations: NEMA 4X.

Field Elements: Outside.

Special Environmental Requirements: Design panels for continuous operation in environments listed:

Building Sump Local Control Panel to be installed inside Cell No. 1 and Cell No. 2 Crest Pad Buildings.

Transfer Pump Local Control Panel to be installed inside Cell No. 1 and Cell No. 2 Leachate Transfer Buildings.

Leachate Storage Tank Local Control Panel to be installed outdoors adjacent to Cell No. 1 and Cell No. 2 Leachate Storage Tanks.

Combined Sump Local Control Panel to be installed inside Cell No. 1 and Cell No. 2 Crest Pad Buildings.

Control Panel to be installed inside Cell No. 1 and Cell No. 2 Crest Pad Buildings.

Environmental Design Requirements: Environmental conditions are defined below:

Inside:

Temperature: 10 to 30 degrees C.

Relative Humidity: 15 to 90 percent noncondensing.

NEC Classification: Nonhazardous.

Outside:

Temperature: Minus 40 to 40 degrees C.

Relative Humidity: 15 to 90 percent noncondensing.

NEC Classification: Nonhazardous (except for interior of Combined Sump Assemblies).

Snow Accumulation: 5 inches.

SEQUENCING AND SCHEDULING:

Activity Completion: The following is a list of key activities and their completion criteria:

Shop Drawings: Reviewed and approved.

Factory Demonstration Testing of Control Panels: Reviewed and accepted.

Hardware Delivery: Hardware delivered to site and inventoried by Tank Farm Contractor.

~~ORT~~PCT: Completed and required test documentation accepted.

~~PAT~~PFT: Completed and required test documentation accepted.

PICS Substantial Completion: When Construction Manager issues Certificate of Substantial Completion.

Prerequisites:

All PICS Submittals have been completed.

PICS has successfully completed FDT and PFT~~PAT~~.

Tank Farm Contractor training plan is on schedule.

All spares, expendables, and test equipment have been delivered to Tank Farm Contractor.

PICS Acceptance: When Construction Manager issues a written notice of Final Payment and Acceptance.

Prerequisites:

Certificate of Substantial Completion issued for PICS.

Punch-list items completed.

Final revisions to O&M manuals accepted.

Maintenance service agreements for PICS ~~accepted by Tank Farm Contractor.~~ which shall satisfy the following requirements:

Duration of 2 years unless negotiated with Tank Farm Contractor.

Start on date of PICS acceptance, as identified in Section 13401, PICS, Article SEQUENCING AND SCHEDULING, Paragraph PICS Acceptance.

Performed by factory trained service engineers with experience on PICS systems to be maintained.

All materials and labor for preventive maintenance and visit site bimonthly.

All materials and labor for demand maintenance with coverage 8:00 a.m. to 5:00 p.m., Monday through Friday.

Response Time: Service engineer shall be onsite within 24 hours of request by Tank Farm Contractor.

Spare Parts: If not stocked onsite, delivered to Site within 24 hours from time of request.

Repair or replace all components or software found to be faulty.

Replace and restock within 1 month, onsite spare parts and expendables used for maintenance. Provide list of items used and replaced.

Submit records of inspection, maintenance, calibration, repair, and replacement within 2 weeks after each visit to site.

Telephone Support: Coverage 8:00 a.m. to 5:00 p.m., Monday through Friday.

Software Subscription: 2-year support per Section 13401, PICS, Supplements.

Prerequisite Activities and Lead Times: Do not start the following key Project activities until the prerequisite activities and lead times listed below have been completed and satisfied:

Activity	Prerequisites and Lead Times
Submittal reviews by Engineer and Tank Farm Contractor	Tank Farm Contractor acceptance of Submittal breakdown and schedule.
Hardware purchasing, fabrication, and assembly.	Associated shop drawing Submittals completed.
Shipment	Completion of PICS Shop Drawing and Quality Control Submittals, preliminary O&M manuals, and Factory Demonstration Testing.
PCT~~ORT~~	PCT~~ORT~~ procedures completed; notice 3 weeks prior to start.
Tank Farm Contractor Training	Tank Farm Contractor training plan completed.
PFT~~PAT~~	Startup, Tank Farm Contractor training, and ~~PAT~~ PFT procedures completed; notice 4 weeks prior to start.

PART 2--PRODUCTS

GENERAL:

The general functions of the PICS are as depicted on the Drawings. The PICS Contractor shall provide a full-featured system that is complete, calibrated, and fully operational.

Like Equipment Items:

Use products of one manufacturer and of the same series or family of models to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer's services.

Implement all same or similar functions in same or similar manner. For example, control logic, sequence controls, and display layouts.

LOOP SPECIFICATIONS:

Location: Article SUPPLEMENTS.

Organization: By unit process and loop number.

Functional Requirements for Control Loops:

Shown on Drawings, in Panel Control Diagrams, and Process and Instrumentation Diagrams (P&ID). P&ID format and symbols are in accordance with ISA S5.1, except as specified or shown on Drawings.

Supplemented by Loop Specifications.

Subheadings for Each Loop:

Functions: Clarifies functional performance of loop, including abstract of interlocks.

Components: Lists major components for each loop. Information listed include: Tag numbers.

Component Identification Codes: Alphanumeric codes of required components. Refer to Component Specification referenced in Article SUPPLEMENTS.

Component Names and Options: Required to tailor general Component Specifications to specific application. For example, special materials, mounting, size, unit range, scale, set points, and controller options.

I&C COMPONENTS:

Components for Each Loop: Major components for each loop are listed in Instrument List referenced in Article SUPPLEMENTS. Furnish all equipment that is necessary to achieve required loop performance.

Component Specifications: Generalized specifications for each type of component are located in Article SUPPLEMENTS.

NAMEPLATES AND TAGS:

Panel Nameplates: Enclosure identification located on the enclosure face.

Location and Inscription: As shown.

Materials: Laminated plastic attached to panel with stainless steel screws.

Letters: 1/2-inch white on black background, unless otherwise noted.

Component Nameplates—Panel Face: Component identification located on panel face under or near component.

Location and Inscription: As shown.

Materials: Laminated plastic attached to panel with stainless steel screws.

Letters: 3/16-inch white on black background, unless otherwise noted.

Component Nameplates—Back of Panel: Component identification located near component inside of enclosure.

Inscription: Component tag number.

Materials: Adhesive backed, laminated plastic.

Letters: 3/16-inch white on black background, unless otherwise noted.

Legend Plates for Panel Mounted Pushbuttons, Lights, and Switches:

Inscription: Refer to:

Table under paragraph Standard Pushbutton Colors and Inscriptions.

Table under paragraph Standard Light Colors and Inscriptions.

P&IDs in Drawings.

Materials: Engraved plastic, keyed legend plates. Secured to panel by mounting nut for pushbutton, light, or switch.

Letters: Black on gray or white background.

Service Legends: Component identification nameplate located on face of component.

Inscription: As shown.

Materials: Adhesive backed, laminated plastic.

Letters: 3/16-inch white on black background, unless otherwise noted.

Nametags: Component identification for field devices.

Inscription: Component tag number.

Materials: 16-gauge, Type 304 stainless steel.

Letters: 3/16-inch imposed.

Mounting: Affix to component with 16- or 18-gauge stainless steel wire or stainless steel screws.

ELECTRICAL REQUIREMENTS:

In accordance with Division 16, ELECTRICAL.

I&C and electrical components, terminals, wires, and enclosures: UL recognized or UL listed.

Wires Within Enclosures:

ac Circuits:

Type: 600-volt, Type SIS stranded copper.

Size: For current to be carried, but not less than No. 14 AWG.

Analog Signal Circuits:

Type: 600-volt stranded copper, twisted shielded pairs.

Size: No. 16 AWG, minimum.

Other dc Circuits:

Type: 600-volt, Type SIS stranded copper.

Size: For current carried, but not less than No. 18 AWG.

Special Signal Circuits: Use manufacturer's standard cables.

Wire Identification: Numbered and tagged at each termination.

Wire Tags: Snap-on or slip-on PVC wire markers with legible machine printed markings and numbers. Adhesive or taped-on tags are not acceptable.

Wires entering or leaving enclosures, terminate and identify as follows:

Analog and discrete signal, terminate at numbered terminal blocks.

Special signals, terminated using manufacturer's standard connectors.

Identify wiring in accordance with Division 16, ELECTRICAL.

Terminal Blocks for Enclosures:

Wire spare PLC I/O points to terminal blocks.

One wire per terminal for field wires entering enclosures.

Maximum of two wires per terminal for 18-WG wire for internal enclosure wiring.

Spare Terminals: 20 percent of all connected terminals, but not less than 5 per terminal block.

General:

Connection Type: Screw compression clamp.

Compression Clamp:

Complies with DIN-VDE 0611.

Hardened steel clamp with transversal groves that penetrate wire strands providing a vibration-proof connection.

Guides strands of wire into terminal.

Screws: Hardened steel, captive and self-locking.

Current Bar: Copper or treated brass.

Insulation:

Thermoplastic rated for minus 55 to plus 110 degree C.

Two funneled shaped inputs to facilitate wire entry.

Mounting:

Standard DIN rail.

Terminal block can be extracted from an assembly without displacing adjacent blocks.

End Stops: Minimum of one at each end of rail.

Wire Preparation: Stripping only permitted.

Jumpers: Allow jumper installation without loss of space on terminal or rail.

Marking System:

Terminal number shown on both sides of terminal block.

Allow use of preprinted and field marked tags.

Terminal strip numbers shown on end stops.

Mark terminal block and terminal strip numbers as shown on Panel Control Diagrams and Loop Diagrams.

Terminal Block, General-Purpose:

Rated Voltage: 600V ac.

Rated Current: 30 amp.

Wire Size: No. 22 to No. 10 AWG.

Rated Wire Size: No. 10 AWG.

Color: Grey body.

Spacing: 0.25 inch, maximum.

Test Sockets: One screw test socket 0.079-inch diameter.

Manufacturer and Product: Entrelec; Type M4/6.T.

Terminal Block, Ground:

Wire Size: No. 22 to No. 12 AWG.

Rated Wire Size: No. 12 AWG.

Color: Green and yellow body.

Spacing: 0.25 inch, maximum.

Grounding: Ground terminal blocks electrically grounded to the mounting rail.

Manufacturer and Product: Entrelec; Type M4/6.P.

Terminal Block, Blade Disconnect Switch:

Rated Voltage: 600V ac.

Rated Current: 10-amp.

Wire Size: No. 22 to No. 12 AWG.

Rated Wire Size: No. 12 AWG.

Color: Grey body, orange switch.

Spacing: 0.25 inch, maximum.

Manufacturer and Product: Entrelec; Type M4/6.SN.T.

Terminal Block, Fused, 24V dc:

Rated Voltage: 600V dc.

Rated Current: 16-amp.

Wire Size: No. 22 to No. 10 AWG.

Rated Wire Size: No. 10 AWG.

Color: Grey body.

Fuse: 0.25 inch by 1.25 inches.

Indication: LED diode 24V dc.

Spacing: 0.512 inch, maximum.

Manufacturer and Product: Entrelec; Type M10/13T.SFL.

Terminal Block, Fused, 120V ac:

Rated Voltage: 600V ac.

Rated Current: 16-amp.

Wire Size: No. 22 to No. 10 AWG.

Rated Wire Size: No. 10 AWG.

Color: Grey body.

Fuse: 0.25 inch by 1.25 inches.

Indication: Neon Lamp 110V ac.

Leakage Current: 1.8 mA, maximum.

Spacing: 0.512 inch, maximum.

Manufacturer and Product: Entrelec; Type M10/13T.SFL.

Terminal Block, Fused, 120V ac, High Current:

Rated Voltage: 600V ac.

Rated Current: 35 amps.

Wire Size: No. 18 to No. 8 AWG.

Rated Wire Size: No. 8 AWG.

Color: Grey.

Fuse: 13/32 inch by 1.5 inches.

Spacing: 0.95 inch, maximum.

Manufacturer and Product: Entrelec; Type MB10/24.SF.

Grounding of Enclosures:

Furnish copper isolated ground bus. Take car to ensure that this bus is connected to the safety ground bus at only one point.

Single Point Ground for Each Analog Loop:

Group and connect shields in following locations:

Control Panel.

Ground terminal block rails to ground bus.

Analog Signal Isolators: Furnish signal isolation for analog signals that are sent from one enclosure to another and where required to provide proper function. Do not wire in series instruments on different panels, cabinets, or enclosures.

Power Distribution Within Panels:

Feeder Circuits:

One or more 120V ac, 60-Hz feeder circuits as shown on Drawings.

Make provisions for feeder circuit conduit entry.

Furnish terminal blocks for termination of wires.

Power Panel: Furnish main circuit breaker and a circuit breaker on each individual branch circuit distributed from power panel.

Locate to provide clear view of and access to breakers when door is open.

Breaker Sizes: Coordinate such that fault in branch circuit will blow only branch breaker but not trip the main breaker.

Branch Circuit Breaker: Select size of circuit breaker to suit load at 250V ac.

Breaker Manufacturers and Products: Allen-Bradley 1492-GH.

Circuit Wiring: P&IDs and Control Diagrams on Drawings show function only. Use following rules for actual circuit wiring:

Devices on Single Circuit: 20, maximum.

Multiple Units Performing Parallel Operations: To prevent failure of any single branch circuit from shutting down entire operation, do not group all units on same branch circuit.

Branch Circuit Loading: 12 amperes continuous, maximum.

Panel Lighting and Service Outlets: Put on separate 15-amp, 120V ac branch circuit.

Provide 120-volt ac plugmold for panel components with line cords.

Signal Distribution:

Within Panels: 4 to 20 mA dc signals may be distributed as 1 to 5V dc.

Outside Panels: Isolated 4 to 20 mA dc only.

All signal wiring in twisted shielded pairs.

Between Panels: 4 to 20 mA dc signals isolated by current signal isolators.

Signal Switching:

Use dry circuit type relays or switches.

No interruption of 4 to 20 mA loops during switching.

Switching Transients in Associated Signal Circuit:

4 to 20 mA dc Signals: 0.2 mA, maximum.

1 to 5V dc Signals: 0.05V, maximum.

Current Signal Isolators:

Solid state three- and four-way isolation of the input signal, two output signals, and external power supply.

Features:

Zero and span trim adjustments using 15-turn potentiometers.

Calibration independent of load.

Signal Interface:

Input: 4 to 20 mA dc maximum impedance: 75 ohms.

Output: Two 4 to 20 mA dc. Capable of drives output load impedance up to 1,050 ohms independent of supply voltage to isolator.

Enclosure: NEMA 1, unless otherwise noted.

Mounting: DIN rail, unless otherwise noted.

Power: 115V ac, unless otherwise noted.

Manufacturer: Moore ECT Isolators; or approved equal.

Intrinsic Safety:

Programmable three-channel switching amplifier with intrinsically safe input circuits, used to isolate and transfer discrete signals from Class I, Class II, or Class III hazardous location to a nonhazardous location.

Inputs: Three-channel dry contact inputs to switching amplifier.

Outputs: Three-channel SPDT dry relay contact outputs, each selectable to be (N.O.) or (N.C.) Output function dependent upon input condition.

Indications: Two-color switching status LED for each channel. "Yellow" LED when output relay is energized. "Green" LED with power ON status, "Red" LED for Fault Condition.

Supply Voltage: 10-30 VDC.

Power Consumption: >2 watts.

Output contact Ratings: 500 VA/60W.

Approvals and Certifications: FM approved, and CSA Certified.

Manufacturer and Product: TURK MD13-231Ex0-R/24VDC or equal.

Relays:

General:

Relay Mounting: Plug-in type socket.

Relay Enclosure: Furnish dust cover.

Socket Type: Screw terminal interface with wiring.

Socket Mounting: Rail.

Provide holddown clips.

Control Circuit Switching Relay, Nonlatching:

Type: Compact general-purpose plug-in.

Contact Arrangement: 3 Form C contacts.

Contact Rating: 10A at 28V dc or 240V ac.

Contact Material: Silver cadmium oxide alloy.

Coil Voltage: As noted or shown.

Coil Power: 1.2 watts (dc), 1.75VA (ac).

Expected Mechanical Life: 10,000,000 operations.

Expected Electrical Life at Rated Load: 100,000 operations.

Indication Type: Neon or LED indicator lamp.

Push to test button.

Manufacturer and Product: Allen-Bradley; 700-HA Series.

For all 11-pin relays use Allen-Bradley 700-HN203. For 8-pin relays, use Allen-Bradley 700-HN203.

Control Circuit Switching Relay, Latching:

Type: Dual coil mechanical latching relay.

Contact Arrangement: 2 Form C contacts.

Contact Rating: 10A at 28V dc or 120V ac.

Contact Material: Silver cadmium oxide alloy.

Coil Voltage: As noted or shown.

Coil Power: 2.7 watts (dc), 5.3VA (ac).

Expected Mechanical Life: 500,000 operations.

Expected Electrical Life at Rated Load: 50,000 operations.

Manufacturer and Product: Potter and Brumfield; Series KB/KBP.

Control Circuit Switching Relay, Time Delay:

Type: Adjustable time delay relay.

Contact Arrangement: 3 Form C contacts.

Contact Rating: 10A at 240V ac.

Contact Material: Silver cadmium oxide alloy.

Coil Voltage: As noted or shown.

Operating Temperature: Minus 10 to 55 degrees C.

Repeatability: Plus or minus 0.5 percent.

Timing Module: Solid state multifunction plug-in module. Plugs into socket to add timing feature to general purpose relay.

Manufacturer and Products: Allen-Bradley 700-HT1 for ac, 700-HT2 for dc.

Power Supplies:

Furnish to power instruments requiring external dc power, including two-wire transmitters and dc relays.

Convert 120V ac, 60-Hz power to dc power of appropriate voltage(s) with plus or minus 0.05 percent voltage regulation and ripple control to assure that instruments being supplied can operate within their required tolerances.

Provide output over voltage and over current protective devices to:

Protect instruments from damage due to power supply failure.

Protect power supply from damage due to external failure.

Enclosures: NEMA 1 in accordance with NEMA 250.

Mount such that dissipated heat does not adversely affect other components.

Fuses: For each dc supply line to each individual two-wire transmitter.

Type: Indicating.

Mount so fuses can be easily seen and replaced.

Resistors: All resistors used to derive a 1-5V dc signal from a 4-20 mA dc signal shall be 250 ohm, ±1 percent, 3 watts, axial lead, non-inductive wire wound, welded construction, silicone coated, 1,000V ac dielectric. Vishay-Dale RS-2B-NS or equal. 250 ohms is a standard value in this line, and use of a resistance other that 250 ohms is not acceptable.

Internal Panel Lights for Freestanding Panels:

Type: Switched 100-watt fluorescent back-of-panel lights.

Quantity: One light for every 4 feet of panel width.

Mounting: Inside and in the top of back-of-panel area.

Protective metal shield for lights.

Service Outlets for Freestanding Panels:

Type: Three-wire, 120-volt, 15-ampere, GFI duplex receptacles.

Quantity:

For Panels 4 Feet Wide and Smaller: One.

For Panels Wider Than 4 Feet: One for every 4 feet of panel width, two minimum per panel.

Mounting: Evenly spaced along back-of-panel area.

Standard Pushbutton Colors and Inscriptions: Use following color code and inscriptions for pushbuttons, unless otherwise noted in Instrument List, Article SUPPLEMENTS.

Tag Function	Inscription(s)	Color
OO	ON	Red
	OFF	Green
OC	OPEN	Red
	CLOSE	Green
OCA	OPEN	Red
	CLOSE	Green
	AUTO	White
OOA	ON	Red
	OFF	Green
	AUTO	White
MA	MANUAL	Yellow
	AUTO	White
SS	START	Red
	STOP	Green
RESET	RESET	Red
EMERGENCY STOP	EMERGENCY STOP	Red

Unused or Noninscribed Buttons: Black.

Standard Light Colors and Inscriptions: The following table gives the inscriptions for service legends, and the lens colors for indicating lights.

Tag Function	Inscription(s)	Color
ON	ON	Red
OFF	OFF	Green
OPEN	OPEN	Red
CLOSED	CLOSED	Green
LOW	LOW	Green
FAIL	FAIL	Amber
HIGH	HIGH	Red
AUTO	AUTO	White
MANUAL	MANUAL	Yellow
LOCAL	LOCAL	White
REMOTE	REMOTE	Yellow

Lettering Color:

Black on white and amber lenses.

White on red and green lenses.

FABRICATION:

General:

Panels with external dimensions and instruments arrangement as shown on Drawings.

Panel Construction and Interior Wiring: In accordance with the National Electrical Code, state and local codes, NEMA, ANSI, UL, and ICECA.

Fabricate panels, install instruments, wire, and plumb, at the PICS factory.

Electrical Work: In accordance with Division 16, ELECTRICAL.

Shop Assembly: No panel assembly other than correction of minor defects or minor transit damage shall be done on panels at site.

<u>UL Label for Enclosures:</u> UL label stating "Listed Enclosed Industrial Control Panel."

<u>Wiring Within PICS Panels:</u>

Routed through slotted PVC wiring duct with mating cover.

<u>Hinge Wiring:</u> Secure at each end so that bending or twisting will be around longitudinal axis of wire. Protect bend area with sleeve.

Arrange wiring neatly, cut to proper length, and remove surplus wire.

Abrasion protection for wire bundles which pass through holes or across edges of sheet metal.

<u>Connections to Screw Type Terminals:</u>

Locking-fork-tongue or ring-tongue lugs.

Use manufacturer's recommended tool with required sized anvil to make crimp lug terminations and to avoid crossovers at a 90 degree angle.

Wires terminated in a crimp lug, maximum of one.

Lugs installed on a screw terminal, maximum of two.

<u>Connections to Compression Clamp Type Terminals:</u>

Strip, prepare, and install wires in accordance with terminal manufacturer's recommendations.

Wires installed in a compression screw and clamp, maximum of one for field wires entering enclosure, otherwise maximum of two, or quantity as approved by manufacturer.

Splicing and tapping of wires, allowed only at device terminals or terminal blocks.

Terminate 24V dc and analog terminal blocks separate from 120V ac circuit terminal blocks.

Separate analog and dc circuits by at least 6 inches from ac power and control wiring, except at unavoidable crossover points and at device terminations.

Arrange wiring to allow access for testing, removal, and maintenance of circuits and components.

Plastic Wire Ducts Fill: Do not exceed manufacturer's recommendation.

Temperature Control:

Freestanding Panels:

Nonventilated Panels: Size to adequately dissipate heat from equipment mounted inside panel or on panel.

Ventilated Panels:

Provide all ventilated panels with louvers and fans with filters or other cooling means as required to maintain internal temperature between 40 degrees F to 90 degrees F.

For panels with backs against wall, furnish louvers on top and bottom of panel sides.

For panels without backs against wall, furnish louvers on top and bottom of panel back.

Louver Construction: Stamped sheet metal.

Ventilation Fans:

Furnish where required to provide adequate cooling.

Create positive internal pressure within panel.

Fan Motor Power: 120 volts, 60-Hz ac, thermostatically controlled.

Air Filters: Washable aluminum, Hoffman Series A-FLT.

Refrigerated System: Furnish where heat dissipation cannot be adequately accomplished with natural convection or forced ventilation. Smaller Panels (that are not freestanding): Size to adequately dissipate heat from equipment mounted inside panel or in panel face.

Freestanding Panel Construction:

Materials: Sheet steel, unless otherwise shown on Drawings with minimum thickness of 12-gauge, unless otherwise noted.

Panel Fronts:

Fabricated from a single piece of sheet steel, unless otherwise shown on Drawings.

No seams or bolt heads visible when viewed from front.

Panel Cutouts: Smoothly finished with rounded edges.

Stiffeners: Steel angle or plate stiffeners or both on back of panel face to prevent panel deflection under instrument loading or operation.

Internal Framework:

Structural steel for instrument support and panel bracing.

Permit panel lifting without racking or distortion.

Lifting rings to allow simple, safe rigging and lifting of panel during installation.

Adjacent Panels: Securely bolted together so front faces are parallel.

Doors: Full height, fully gasketed access doors where shown on Drawings.

Latches: Three-point, Southco Type 44.

Handles: "D" ring, foldable type.

Hinges: Full length, continuous, piano type, steel hinges with stainless steel pins.

Rear Access Doors: Extend no further than 24 inches beyond panel when opened to 90-degree position.

Front and Side Access Doors: As shown on Drawings.

Nonfreestanding Panel Construction:

Based on environmental design requirements required and referenced in Article ENVIRONMENTAL REQUIREMENTS, provide the following:

For panels listed as inside:

Enclosure Type: NEMA 12 in accordance with NEMA 250.

Materials: Steel.

For all other panels:

Enclosure Type: NEMA 4X in accordance with NEMA 250.

Materials: Type 316 stainless steel.

Metal Thickness: 14-gauge, minimum.

Doors:

Rubber-gasketed with continuous hinge.

Stainless steel lockable quick-release clamps.

Manufacturers:

Hoffman Engineering Co.

H. F. Cox.

Factory Finishing:

Enclosures:

Stainless Steel and Aluminum: Not painted.

Nonmetallic Panels: Not painted.

Steel Panels:

Sand panel and remove mill scale, rust, grease, and oil.

Fill imperfections and sand smooth.

Prepare metal and paint panel interior and exterior with one coat of epoxy coating metal primer, two finish coats of two-component type epoxy enamel.

Sand surfaces lightly between coats.

Dry Film Thickness: 3 mils, minimum.

Color: Light gray.

Manufacturer's standard finish color, except where specific color is indicated. If manufacturer has no standard color, finish equipment with light gray color.

CORROSION PROTECTION:

Corrosion-Inhibiting Vapor Capsule Manufacturers:

Northern Instruments; Model Zerust VC.

Hoffmann Engineering Co; Model A-HCI.

SOURCE QUALITY CONTROL:

Factory Demonstration Testing (FDT):

Scope: Test PICS control panels to demonstrate panel assemblies are operational, prior to shipment:

Location: PICS factory.

Loop-Specific Functions: Demonstrate proper functions for each control loop, as shown on P&IDs and as required.

Make following documentation available to Construction Manager both before and after FDT:

Master copy of FDT procedures.

List of equipment to be tested including make, model, and serial number.

Equipment and loop verification sheets signed by PICS Construction Subcontractor showing that each equipment and loop has been tested and has functioned properly.

PART 3--EXECUTION

EXAMINATION:

For equipment not provided by PICS, but that directly interfaces with the PICS, verify the following conditions:

Proper installation.

Calibration and adjustment of positioners and I/P transducers.

Correct control action.

Switch settings and dead bands.

Opening and closing speeds and travel stops.

Input and output signals.

Report discrepancies to the Construction Manager.

INSTALLATION:

Material and Equipment Installation: Retain a copy of manufacturers' instructions at site, available for review at all times.

Electrical Wiring: As specified in Division 16, ELECTRICAL

Removal or Relocation of Materials and Equipment:

Remove from site materials that were part of the existing facility but are no longer used, unless otherwise directed by Construction Subcontractor to deliver to Construction General Contractor.

Repair affected surfaces to conform to type, quality, and finish of surrounding surface.

CONSTRUCTION QUALITY CONTROL

Testing:

Onsite testing shall be required for each major process instrumentation and control system in accordance with this section and submitted/accepted test procedures. Provide personnel and equipment in support of PICS Continuity (PCT) and PICS Functionality (PFT) testing.~~Operation Readiness (ORT) and Performance Acceptance (PAT) testing.~~

Tests shall be performed to demonstrate that each function is implemented and operational. These tests are electrical component tests to be performed in advance of facility-wide construction acceptance testing (CAT). CAT shall be performed in accordance with Division 1 requirements. Copies of all tests shall be submitted as specified herein.

Startup and Testing Team:

Thoroughly inspect installation, termination, and adjustment for components and systems.

Complete onsite tests.

Complete onsite training.

Provide startup assistance.

PICS Continuity Test (PCT) ~~Operational Readiness Testing (ORT)~~ Inspections and Calibrations: Prior to startup, inspect and test to ensure that entire PICS is ready for operation.

Loop/Component Inspections and Calibrations:

Check PICS for proper installation, calibration, and adjustment on a loop-by-loop and component-by-component basis.

Prepare component calibration sheet for each active component (except simple hand switches, lights, gauges, and similar items).

Project name.

Loop number.

Component tag number.

Component code number.

Manufacturer for elements.

Model number/serial number.

Summary of functional requirements, for example:

Indicators and recorders, scale and chart ranges.

Transmitters/converters, input and output ranges.

Computing elements' function.

Switching elements, unit range, differential (fixed/adjustable), reset (auto/manual).

Calibrations, for example:

Analog Devices: Actual inputs and outputs at 0, 10, 50, and 100 percent of span, rising and falling.

Discrete Devices: Actual trip points and reset points.

Space for comments.

These inspections and calibrations will be witnessed by the Construction Manager or designated representative(s).

PICS Functionality Test (PFT)~~Performance Acceptance Tests (PAT)~~:

General:

Test all PICS elements to demonstrate that PICS satisfies all requirements.

Test Format: Cause and effect.

Person conducting test initiates an input (cause).

Specific test requirement is satisfied if correct result (effect) occurs.

Procedures, Forms, and Checklists:

Conduct tests in accordance with, and documented on, Tank Farm Contractor accepted procedures, forms, and checklists.

Describe each test item to be performed.

Have space after each test item description for sign off by appropriate party after satisfactory completion.

Required Test Documentation: Test procedures, forms, and checklists. All signed by Construction Manager and Construction General Contractor.

Conducting Tests:

Provide special testing materials, equipment, and software.

Wherever possible, perform tests using actual process variables, equipment, and data.

If it is not practical to test with real process variables, equipment, and data, provide suitable means of simulation.

Define simulation techniques in test procedures.

Coordinate PICS testing with Construction Manager and affected Construction Subcontractors.

Test Requirements:

Once facility has been started up and is operating, perform a witnessed PFT ~~PAT~~ on complete PICS to demonstrate that it is operating as required. Demonstrate each required function on a paragraph-by-paragraph and loop-by-loop basis.

Perform local and manual tests for each loop before proceeding to remote and automatic modes.

Where possible, verify test results using visual confirmation of process equipment and actual process variable. Unless otherwise directed, exercise and observe devices supplied by others, as needed to verify correct signals to and from such devices and to confirm overall system functionality. Test verification by means of disconnecting wires or measuring signal levels is acceptable only where direct operation of plant equipment is not possible.

Make updated versions of documentation required for PFT ~~PAT~~ available to Construction Manager at site, both before and during tests.

Make one copy of O&M manuals available to Construction Manager at the site both before and during testing.

TRAINING:

General:

Provide an integrated training program to meet specific needs of Tank Farm Contractor's personnel in accordance with submitted and accepted training plan.

Include training sessions, classroom and field, for managers, engineers, operators, and maintenance personnel.

Provide instruction on two working shifts as needed to accommodate the Tank Farm Contractor's personnel schedule.

Tank Farm Contractor reserves the right to make and reuse video tapes of training sessions.

Provide reference handouts that cover the course content for all personnel attending any course or training session.

Operations and Maintenance Training:

Include a review of O&M manuals and survey of spares, expendables, and test equipment.

Use equipment similar to that provided or currently owned by Tank Farm Contractor.

Provide training suitable for instrument technicians with at least a 2-year associate engineering or technical degree, or equivalent education and experience in electronics or instrumentation.

Operations Training:

Training Session Duration: One 8-hour instructor days.

Number of Training Sessions: Two.

Location: Site.

Content: Conduct training on loop-by-loop basis.

Loop Functions: Understanding of loop functions, including interlocks for each loop.

Loop Operation: For example, adjusting process variable set points, AUTO/MANUAL control transfer, AUTO and MANUAL control, annunciator acknowledgement and resetting.

Interfaces with other control systems.

Maintenance Training:

Training Session Duration: One 8-hour instructor days.

Number of Training Sessions: One.

Location: Project site.

<u>Content:</u> Provide training for each type of component and function provided.

<u>Loop Functions:</u> Understanding details of each loop and how they function.

Component calibration.

<u>Adjustments:</u> For example, controller tuning constants, current switch trip points, and similar items.

Troubleshooting and diagnosis for components.

Replacing lamps, fuses.

Component removal and replacement.

Periodic maintenance.

<u>CLEANING/ADJUSTING:</u>

Repair affected surfaces to conform to type, quality, and finish of surrounding surface.

<u>Cleaning:</u>

Prior to closing system using tubing, clear tubing of interior moisture and debris.

Upon completion of Work, remove materials, scraps, and debris from interior and exterior of equipment.

<u>PROTECTION:</u>

Protect enclosures and other equipment containing electrical, instrumentation and control devices, including spare parts, from corrosion through the use of corrosion-inhibiting vapor capsules.

Periodically replace capsules in accordance with capsule manufacturer's recommendations. Replace capsules just prior to Final Payment and Acceptance.

SUPPLEMENTS:

Supplements listed below, following "END OF SECTION," are part of this Specification.

Supplement 1—Instrument Listing for Cell No. 1 and Cell No. 2.

Supplement 2—Component Specifications.

Supplement 3—PLC Input and Output List.

Supplement 4—Loop Specifications.

END OF SECTION 13401

INSTRUMENT LISTING FOR CELL NO. 1 AND CELL NO. 2													
Item	Rev	Tag 1	Tag 2	Tag 3	Tag 4	Description	Description	Drawing	Component Number	Process Ranges	Eng. Units	Detail	Comments
		Area	Process	ISA	Eqt #								
1	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Enclosure	H-2-830855	Reference 13401 PICS	NA		Reference Controls on Dwg. H-2-830857 sheet 1	48"W x 20"D x 72"High NEMA 12
2	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Operator Interface Unit	H-2-830855	Y50	NA			Ethernet Communication
20	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Main and Sub Breakers	H-2-830855	Reference 13401 PICS	NA			
21	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	High Density Breakers	H-2-830855	Reference 13401 PICS	NA			
22	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Surge Protection	H-2-830855	Reference 13401 PICS	NA			
23	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	24 V dc Power Supplies	H-2-830855	Reference 13401 PICS	NA			Size power supplies for all control loops and various local control panel power
24	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	PLC, I/O, Power Supply and Chassis	H-2-830855	Y50	NA			
24	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	PLC Programming and Communication Software	H-2-830855	Y50	NA			
24	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Programming Laptop	H-2-830855	Y50	NA			
25	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Ethernet Switch and Mouting Bracket	H-2-830855	Y50	NA			
26	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Wiring Duct	H-2-830855	Reference 13401 PICS	NA			
27	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Wiring Terminal Strips Analog	H-2-830855	Reference 13401 PICS	NA			
28	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Interposing Relays	H-2-830855	Reference 13401 PICS	NA			
29	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Wiring Terminal Strips Discrete and Power	H-2-830855	Reference 13401 PICS	NA			
3	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Locking Mechanism	H-2-830855	Reference 13401 PICS	NA			
30	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Cooling Fan	H-2-830855	Reference 13401 PICS	NA			
30	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Temperature Thermostat	H-2-830855	Reference 13401 PICS	NA		Reference Controls on Dwg. H-2-830857 sheet 2	

INSTRUMENT LISTING FOR CELL NO. 1 AND CELL NO. 2													
Item	Rev	Tag 1	Tag 2	Tag 3	Tag 4	Description	Description	Drawing	Component Number	Process Ranges	Eng. Units	Detail	Comments
		Area	Process	ISA	Eqt #								
31	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Programming Receptacle	H-2-830855	Reference 13401 PICS	NA			
32	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Uninterruptible Power Supply	H-2-830855	Y40	NA		Reference Controls on Dwg. H-2-830857 sheet 2	1050 VA, 120V in - 120V out
33	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Incandescent Lighting	H-2-830855	Reference 13401 PICS	NA			
34	1	219(Y)	LH	CP	001	Crest Pad Building Control Panel	Signal Isolators	H-2-830855	Reference 13401 PICS	NA		Reference Controls on Dwg. H-2-830857 sheet 2	
40	1	219(Y)	LH	LCP	002	Crest Pad Building Sump Local Control Panel	Enclosure	H-2-830855	Reference 13401 PICS	NA		Reference Controls on Dwg. H-2-830857 sheet 2	16"W x 8"D x 16"H NEMA 4X with internal relays, terminals
41	1	219(Y)	LH	LCP	003	Combined Sump Instrinsic Safety Local Control Panel	Enclosure	H-2-830855	Reference 13401 PICS	NA		Reference Controls on Dwg. H-2-830857 sheet 2	16"W x 8"D x 16"H NEMA 4X with internal relays, terminals
68	1	219(Y)201	LH	LCP	004	Leachate Storage Tank Local Control Panel	Enclosure	H-2-830855	Reference 13401 PICS	NA		Reference Controls on Dwg. H-2-830857 sheet 2	16"W x 8"D x 16"H NEMA 4X with internal relays, terminals
42	1	219(Y)1	LH	LCP	005	Leachate Transfer Pump Local Control Panel	Enclosure	H-2-830855	Reference 13401 PICS	NA		Reference Controls on Dwg. H-2-830857 sheet 2	16"W x 8"D x 16"H NEMA 4X with internal relays, terminals
91	1	219(Y)	LH	LCP	208	Secondary Leachate Collection System Local Control Panel	Enclosure	H-2-830854 sheet 1 of 4	Reference 13401 PICS	NA	NA	H-2-830849 sheet 2 of 2	16" W x 18" H x 9" D NEMA 4X - fiberglass reinforced polyester, with Data logger, input/output channel, signal converter, communications, rechargeable battery, and charge controller
4	1	219(Y)	LH	LI	101	Leachate Collection and Removal System	Panel Mount Level Indicator	H-2-830854 sheet 1 of 4	S27	0 to 26.75	Inches		
43	1	219(Y)	LH	LT	101	Leachate Collection and Removal System	Submersible Pressure Transducer	H-2-830854 sheet 1 of 4	L42	0 to 26.75	Inches	Detail No. 6 on Dwg. H-2-830854	Sensor supplied with termination enclosure (TBX)
5	1	219(Y)	LH	LI	104	Leak Detection System	Panel Mount Level Indicator	H-2-830854 sheet 1 of 4	S27	0 to 26.75	Inches		
44	1	219(Y)	LH	LT	104	Leak Detection System	Submersible Pressure Transducer	H-2-830854 sheet 1 of 4	L42	0 to 26.75	Inches	-	Sensor supplied with termination enclosure (TBX) under this section and installed by pump vendor
45	1	219(Y)	LH	HS	105	Crest Pad Building Sump Control Panel	Local Control Panel Mount Handswitch	H-2-830854 sheet 1 of 4	M12	NA	On/Off		Bypass Operation
46	1	219(Y)	LH	LDE	105	Crest Pad Building Sump	Leak Detection Sensor	H-2-830854 sheet 1 of 4	L109	Actuate elevation 720.5	Feet	Detail No. 4 on Dwg. H-2-830854	1/4" stem actuation from bottom
47	1	219(Y)	LH	LSH	105	Crest Pad Building Sump High	Level Float	H-2-830854 sheet 1 of 4	L8	Actuate elevation 722.0	Feet	Detail No. 1 on Dwg. H-2-830854	

INSTRUMENT LISTING FOR CELL NO. 1 AND CELL NO. 2

Item	Rev	Tag 1	Tag 2	Tag 3	Tag 4	Description	Description	Drawing	Component Number	Process Ranges	Eng. Units	Detail	Comments
		Area	Process	ISA	Eqt #								
48	1	219(Y)	LH	LSHH	105	Crest Pad Building Sump High High	Level Float	H-2-830854 sheet 1 of 4	L8	Actuate elevation 723.0	Feet	Detail No. 1 on Dwg. H-2-830854	
49	1	219(Y)	LH	LSL	105	Crest Pad Building Sump Low	Level Float	H-2-830854 sheet 1 of 4	L8	Actuate elevation 721.0	Feet	Detail No. 1 on Dwg. H-2-830854	
50	1	219(Y)	LH	HS	107	Combined Sump Instrinsic Safety Local Control Panel	Local Control Panel Mount Handswitch	H-2-830854 sheet 2 of 4	M12	NA	On/Off		Bypass Operation
51	1	219(Y)	LH	LDE	107	Combined Sump Pump	Leak Detection Sensor	H-2-830854 sheet 2 of 4	L109	Actuate elevation 714.2	Feet	Detail No. 4 on Dwg. H-2-830854	1/4" stem actuation from bottom
52	1	219(Y)	LH	LSH	107	Combined Sump High	Level Float	H-2-830854 sheet 2 of 4	L8	Actuate elevation 718.5	Feet	Detail No. 1 on Dwg. H-2-830854	
53	1	219(Y)	LH	LSHH	107	Combined Sump High High	Level Float	H-2-830854 sheet 2 of 4	L8	Actuate elevation 720.0	Feet	Detail No. 1 on Dwg. H-2-830854	
54	1	219(Y)	LH	LSL	107	Combined Sump Low	Level Float	H-2-830854 sheet 2 of 4	L8	Actuate elevation 715.0	Feet	Detail No. 1 on Dwg. H-2-830854	
55	1	219(Y)	LH	LSLL	107	Combined Sump Low Low	Level Float	H-2-830854 sheet 2 of 4	L8	Actuate elevation 714.9	Feet	Detail No. 1 on Dwg. H-2-830854	
92	1	218(Y)	LH	LT	108	Secondary Leachate Collection System	Submersible Pressure Transducer	H-2-830854 sheet 1 of 4	L42	0 to 26.75	Inches	Detail No. 6 on Dwg. H-2-830856	Signal interface shall be 12V dc supply instead of 24V dc
7	1	219(Y)	LH	FI	202	Leachate Collection and Removal System Low Flow Pump	Panel Mount Flow Indicator	H-2-830854 sheet 1 of 4	S27	0 to 25	GPM		0-30 PSI Range
56	1	219(Y)	LH	FIT	202	Leachate Collection and Removal System Low Flow Pump	In-Line Flow Magmeter	H-2-830854 sheet 1 of 4	F4	0 to 25	GPM	Section A on Dwg. H-2-830847	0-30 PSI Range with integral transmitter
57	1	219(Y)	LH	HS	202	Leachate Collection and Removal System Low Flow Pump	Motor Control Handswitch	H-2-830854 sheet 1 of 4	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
84	1	219(Y)	LH	PI	202	Leachate Collection and Removal System Low Flow Pump	Pressure Gauge	H-2-830854 sheet 1 of 4	P4/P6	0 to 30	PSI		0-30 PSI Range with Diaphragm Seal
58	1	219(Y)	LH	YL	202	Leachate Collection and Removal System Low Flow Pump	Motor Control On Indicator	H-2-830854 sheet 1 of 4	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
8	1	219(Y)	LH	FI	203	Leachate Collection and Removal System High Flow Pump	Panel Mount Flow Indicator	H-2-830854 sheet 1 of 4	S27	0 to 250	GPM		0-60 PSI Range
59	1	219(Y)	LH	FIT	203	Leachate Collection and Removal System High Flow Pump	In-Line Flow Magmeter	H-2-830854 sheet 1 of 4	F4	0 to 250	GPM	Section A on Dwg. H-2-830847	0-60 PSI Range with integral transmitter
60	1	219(Y)	LH	HS	203	Leachate Collection and Removal System High Flow Pump	Motor Control Handswitch	H-2-830854 sheet 1 of 4	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

INSTRUMENT LISTING FOR CELL NO. 1 AND CELL NO. 2

Item	Rev	Tag 1	Tag 2	Tag 3	Tag 4	Description	Description	Drawing	Component Number	Process Ranges	Eng. Units	Detail	Comments
		Area	Process	ISA	Eqt #								
85	1	219(Y)	LH	PI	203	Leachate Collection and Removal System High Flow Pump	Pressure Gauge	H-2-830854 sheet 1 of 4	P4/P6	0 to 60	PSI		0-60 PSI Range with Diaphragm Seal
61	1	219(Y)	LH	YL	203	Leachate Collection and Removal System High Flow Pump	Motor Control On Indicator	H-2-830854 sheet 1 of 4	M12	NA			Provided under Section 16440
9	1	219(Y)	LH	FI	204	Leak Detection System Pump	Panel Mount Flow Indicator	H-2-830854 sheet 1 of 4	S27	0 to 15	GPM		0-15 PSI Range
62	1	219(Y)	LH	FIT	204	Leak Detection System Pump	In-Line Flow Magmeter	H-2-830854 sheet 1 of 4	F4	0 to 15	GPM	Section A on Dwg. H-2-830847	0-15 PSI Range with integral transmitter
63	1	219(Y)	LH	HS	204	Leak Detection System Pump	Motor Control Handswitch	H-2-830854 sheet 1 of 4	M12	NA			Provided under Section 16440
86	1	219(Y)	LH	PI	204	Leak Detection System Pump	Pressure Gauge	H-2-830854 sheet 1 of 4	P4/P6	0 to 15	PSI		0-15 PSI Range with Diaphragm Seal
64	1	219(Y)	LH	YL	204	Leak Detection System Pump	Motor Control On Indicator	H-2-830854 sheet 1 of 4	M12	NA			Provided under Section 16440
65	1	219(Y)	LH	HS	205	Crest Pad Building Sump Pump	Motor Control Handswitch	H-2-830854 sheet 1 of 4	M12	NA			Provided under Section 16440
89	1	219(Y)	LH	PI	205	Crest Pad Building Sump Pump	Pressure Gauge	H-2-830854 sheet 1 of 4	P4/P6	0 to 15	PSI		0-15 PSI Range with Diaphragm Seal
66	1	219(Y)	LH	YL	205	Crest Pad Building Sump Pump	Motor Control On Indicator	H-2-830854 sheet 1 of 4	M12	NA			Provided under Section 16440
67	1	219(Y)	LH	HS	207	Combined Sump Pump	Motor Control Handswitch	H-2-830854 sheet 2 of 4	M12	NA			Provided under Section 16440
69	1	219(Y)	LH	YL	207	Combined Sump Pump	Motor Control On Indicator	H-2-830854 sheet 2 of 4	M12	NA			Provided under Section 16440
12	1	219(Y)	LH	HS	219	Crest Pad Building	Control Panel Mount Switch	H-2-830854 sheet 1 of 4	M12	NA			Alarm Acknowledge Switch
70	1	219(Y)	LH	JSH	219	Crest Pad Building	Power Relay	H-2-830854 sheet 1 of 4	Reference 13401 PICS	NA			Power Relay mounted inside Control Panel
10	1	219(Y)1	LH	TI	219	Crest Pad Building	Panel Mount Temp Indicator	H-2-830854 sheet 2 of 4	S27	-40 to 40	Celsius		
71	1	219(Y)	LH	TIT	219	Crest Pad Building	Temperature Transmitter	H-2-830854 sheet 1 of 4	T3	-40 to 40	Celsius		With integral transmitter
72	1	219(Y)	LH	YAL	219	Crest Pad Building	Alarm Light	H-2-830854 sheet 1 of 4	M31	NA			

INSTRUMENT LISTING FOR CELL NO. 1 AND CELL NO. 2

Item	Rev	Tag 1	Tag 2	Tag 3	Tag 4	Description	Description	Drawing	Component Number	Process Ranges	Eng. Units	Detail	Comments
		Area	Process	ISA	Eqt #								
11	1	219(Y)1	LH	TI	220	Leachate Transfer Building	Panel Mount Temp Indicator	H-2-830854 sheet 2 of 4	S27	-40 to 40	Celsius		
73	1	219(Y)1	LH	TIT	220	Leachate Transfer Building	Temperature Transmitter	H-2-830854 sheet 2 of 4	T3	-40 to 40	Celsius		With integral transmitter
74	1	219(Y)1	LH	YAL	220	Leachate Transfer Building	Alarm Light	H-2-830854 sheet 2 of 4	M31	NA			
88	1	219(Y)201	LH	HS	301	Leachate Storage Tank Local Control Panel	Local Control Panel Mount Handswitch	H-2-830854 sheet 2 of 4	M12	NA	On/Off		Bypass Operation
75	1	219(Y)201	LH	LSHH	301	Leachate Storage Tank	Level Switch	H-2-830854 sheet 2 of 4	L1A	Actuate elevation 728.3	Feet	Detail No. 2 on Dwg. H-2-830854	
76	1	219(Y)201	LH	LSLL	301	Leachate Storage Tank	Level Switch	H-2-830854 sheet 2 of 4	L1A	Actuate elevation 722.7	Feet	Detail No. 2 on Dwg. H-2-830854	
77	1	219(Y)201	LH	LT	301	Leachate Storage Tank	Submersible Pressure Transducer	H-2-830854 sheet 2 of 4	L42	0 to 108	Inches	Detail No. 3 on Dwg. H-2-830854	Sensor supplied with termination enclosure (TBX) and Lightning Arrestor
78	1	219(Y)201	LH	LI	301-1	Leachate Storage Tank	Local Control Panel Mount Level Indicator	H-2-830854 sheet 2 of 4	S27	0 to 108	Inches		Provide Signal Isolator, and Lightning Arrestor
6	1	219(Y)201	LH	LI	301-2	Leachate Storage Tank	Panel Mount Level Indicator	H-2-830854 sheet 2 of 4	S27	0 to 108	Inches		Provide Signal Isolator
79	1	219(Y)1	LH	HS	302	Leachate Transfer Pump	Panel Mount Motor Control Handswitch	H-2-830854 sheet 2 of 4	M12	NA	On/Off		Motor On/Off control switch
87	1	219(Y)1	LH	PI	302	Leachate Transfer Pump	Pressure Gauge (Load)	H-2-830854 sheet 2 of 4	P4/P6	0 to 15	PSI		0-15 PSI Range with Diaphragm Seal
90	1	219(Y)1	LH	PI	303	Leachate Transfer Pump	Pressure Gauge (Suction)	H-2-830854 sheet 2 of 4	P4/P6	0 to 100	Inches		0-100 Inches Range with Diaphragm Seal
80	1	219(Y)1	LH	FIT/FQI	302-1	Leachate Transfer Pump	In-Line Flow Magmeter	H-2-830854 sheet 2 of 4	F4	0 to 300	GPM	Section A on Dwg. H-2-830851	0-15 PSI Range. Flow and Total Integral with same indicator.
81	1	219(Y)1	LH	YL	302-1	Leachate Transfer Pump	Local Control Panel Mount Motor Control On Indicator	H-2-830854 sheet 2 of 4	M12	NA			
82	1	219(Y)1	LH	FQI	302-2	Leachate Transfer Pump	Local Control Panel Mount Flow Totalizer Indicator	H-2-830854 sheet 2 of 4	S27	0 to 10,000	Gallons		Flow and Total Integral to same meter. Provied Signal Isolator
83	1	219(Y)1	LH	YL	302-2	Leachate Transfer Pump	Motor Control On Indicator	H-2-830854 sheet 2 of 4	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

(Y) = A for Cell No. 1	For Cell No. 1 reference corresponding H-2-830854 sheet 1 of 4 and sheet 2 of 4.
(Y) = E for Cell No. 2	For Cell No. 2 reference corresponding H-2-830854 sheet 3 of 4 and sheet 4 of 4.

COMPONENT SPECIFICATIONS:

F4 Flow Element and Transmitter, Electromagnetic:

General:

Function: Measure, indicate, and transmit the flow of a conductive process liquid in a full pipe.

Type:

Electromagnetic flowmeter, with operation based on Faraday's Law, utilizing the pulsed dc type coil excitation principle with high impedance electrodes.

Full bore meter with magnetic field traversing entire flow-tube cross section. .

Unacceptable are insert magmeters or multiple single point probes inserted into a spool piece.

Parts: Flow element, transmitter, interconnecting cables, and mounting hardware. Other parts as noted.

Service:

Stream Fluid:

As noted.

Suitable for liquids with a minimum conductivity of 5 microS/cm and for demineralized water with a minimum conductivity of 20 microS/cm.

Flow Stream Descriptions: If and as described below.

Operating Temperature:

Element:

Ambient: Minus 5 to 140 degrees F, typical, unless otherwise noted.

Process: Minus 5 to 140 degrees F, typical, unless otherwise noted.

Transmitter:

Ambient: Minus 5 to 140 degrees F, typical, unless otherwise noted.

Storage: 15 to 120 degrees F, typical, unless otherwise noted.

Performance:

Flow Range: As noted.

Accuracy: Plus or minus 0.5 percent of rate for all flows resulting from pipe velocities of 2 to 33 feet per second.

Turndown Ratio: Minimum of 10 to 1 when flow velocity at minimum flow is at least 1 foot per second.

Features:

Zero stability feature to eliminate the need to stop flow to check zero alignment.

No obstructions to flow.

Very low pressure loss.

Measures bi-directional flow.

Process Connection:

Meter Size (diameter inches): As noted.

Connection Type: 150-pound ANSI raised-face flanges or wafer style depending on meter size, unless otherwise noted.

Flange Material: Carbon steel, unless otherwise noted.

Power (Transmitter): 120V ac, 60-Hz, unless otherwise noted.

Element:

Meter Tube Material: Type 304 or 316 stainless steel, unless otherwise noted.

Liner Material:

Teflon, unless otherwise noted.

Low activated waste leachate solution.

Liner Protectors: Covers (or grounding rings) on each end to protect liner during shipment.

Electrode Type: Flush or bullet nose as recommended by the manufacturer for the noted stream fluid.

Electrode Material: Type 316 stainless steel or Hastelloy C, unless otherwise noted.

Grounding Ring:

Required, unless otherwise noted.

Material: Type 316 stainless steel, unless otherwise noted.

Enclosure: NEMA 4X, minimum, unless otherwise noted.

Transmitter:

Mounting: Integral, unless otherwise noted.

Display: Required, unless otherwise noted.

Digital LCD display, indicating flow rate and total.

Bi-directional Flow Display: Required, unless otherwise noted.

Forward flow rate.

Forward, net totalization.

Parameter Adjustments: By keypad or non-intrusive means.

Enclosure: NEMA 4X, minimum, unless otherwise noted.

Empty Pipe Detection: Drives display and outputs to zero when empty pipe

Signal Interface (at Transmitter):

Analog Output:

Isolated 4 to 20 mA dc for load impedance from 0 to at least 500 ohms minimum for 24V dc supply.

Supports Superimposed Digital HART protocol.

Cables:

Types: As recommended by manufacturer.

Lengths: As required to accommodate device locations.

Built-in Diagnostic System:

Features:

Field programmable electronics.

Self-diagnostics with troubleshooting codes.

Ability to program electronics with full scale flow, engineering units, meter size, zero flow cutoff, desired signal damping, totalizer unit digit value, etc.

Initial flow tube calibration and subsequent calibration checks.

Factory Calibration:

Calibrated in an ISO 9001 and NIST certified factory.

Factory flow calibration system must be certified by volume or weight certified calibration devices.

Factory flow calibration system shall be able to maintain calibration flow rate for at least 5 minutes for repeatability point checks.

Factory Ready for Future In situ Verifications: If noted.

Original meter parameter values available from vendor by request.

Accessories:

In situ Verification System: If noted.

Quantity: One complete system provided for the project.

Verifies quantitatively that the meter and signal converter's present condition is the same as originally manufactured.

Physical access to the flow-tube not required.

Meet standards established by the National Testing Laboratory.

Tests and stores over 50-meter parameters related to primary coils, electrodes, interconnecting cable and signal converter.

Verification standard shall be plus or minus 1 percent of wet calibration for meters produced using the calibration verification service, or plus or minus 2 percent for standard meters.

Windows-based software

Primary Simulation System: If noted.

Quantity: One complete system provided for the project.

Verifies proper operation of the signal converter by simulating the flow meter's output signal.

Generates pulsed dc excitation signal with a reference voltage of 70 mV.

Generated signal ranges from 0 to 99 percent (0 to 32.8 feet per second) with a resolution of 0.1 percent.

Switch selectable for forward, reverse and zero flow rate.

Verifies various input and output signals.

Manufacturers:

Krohne Electromagnetic Integral Systems: Aqua Flux Flowmeter (size: 3/8 to 120 inches).

Endress & Hauser, Inc. Flow Measuring System: Promag 50/53W (size: 1 to 78 inches).

Invensys Foxboro (includes IMT 25 Series Intelligent Magnetic Flow Transmitter): 9100A Series Flanged Body Flow Tubes (size: 1 to 78 inches).

L1A Multipoint Level Element and Switches, Admittance:

General:

Function: Operate switches at two separate, distinct, preset product levels in a vessel.

Type: Admittance using low power radio frequency circuit.

Parts: Element and electronics unit. For remote mount, interconnecting cable.

Service: Fluid as noted.

Performance:

Set Points: As noted.

Temperature: Operating range minus 40 to 140 degrees F.

Unaffected by coating buildup on element.

Features:

Electronics Unit:

Filtering: Built-in RFI protection.

Fail-Safe Contacts: Field convertible switch action.

Enclosure Type: Explosion-proof and weatherproof (NEMA 4).

Electronics Mounting: Integrally with element, unless otherwise noted.

When remote, provide cable with length as required to accommodate device locations.

Response Time: 20 milli-seconds standard, or as noted.

Element:

Type: Probe rod.

Insertion Length: As required to achieve noted set points.

Material: 316 stainless steel, unless otherwise noted.

Rating: Element and cable intrinsically safe.

Grounding Element: Required for nonmetallic tank applications.

Process Connection: 3/4-inch NPT unless otherwise noted.

Signal Interface: Contacts, 3 DPDT rated 5A continuous at 120V ac, minimum.

Power: 120V ac 50/60-Hz, or as noted.

Manufacturers and Products:

Drexelbrook; Model 506-3100.

Princo.

Endress & Hauser, Inc.

L8 Level Switch, Float:

General:

Function: Actuate contact at preset liquid level.

Type: Direct-acting float with an enclosed mercury switch and integral cable.

Service: Liquid; low activated waste leachate solution, unless otherwise noted.

Performance:

Set Point: As noted.

Differential: 1-inch maximum.

Temperature: 0 to 180 degrees F.

Features:

Entire Assembly: Watertight and impact-resistant.

Float Material and Size: Polyethylene/foam filled; 4.5-inch diameter tear drop.

Cable:

Combination support and signal.

Length as noted or as necessary per mounting requirements.

Type SO nitrile PVC jacket, AWG No. 18/2 or No. 18/4.

Mounting:

Pipe:

Cable-to-pipe clamp, corrosion-proof cable for 1-inch pipe.

Pipe-to-wall bracket for 1-inch pipe.

Suspended Type: As noted.

Signal Interface:

Switch Type: Mercury tilt.

Switch Contacts:

Isolated, rated 4.5A continuous at 120V ac.

As required (for example 1NO, 1NO+1NC) to meet functional requirements, or as shown.

Manufacturers and Products:

Consolidated Electric Co.; Model LS.

Anchor Scientific; Roto-Float, Type P/Type S.

L42 Level Element/Transmitter, Submersible, Wastewater:

General:

Function: Measure and transmit a signal proportional to level.

Type: Totally submersible pressure sensor (loop powered).

Parts: Sensor, interconnecting cable, sensor termination enclosure.

Service:

Fluid: Wastewater, unless otherwise noted.

Performance:

Process Range:

As noted.

Provide fixed factory range such that noted process range is between 40 and 80 percent of fixed factory range.

Accuracy: 0.25 percent of full scale.

Temperature, Operating: Minus 4 to plus 140 degrees F.

Overpressure: Range dependent.

4X for ranges of 5 psig and above (to a maximum of 2,000 psi).

Greater than 4X for ranges below 5 psig.

Long Term Stability: Plus or minus 0.1 percent full scale/year, typical.

Features:

Sensor:

Silicon sensing element.

Titanium body.

Diaphragm: Elastomeric nitrile rubber, unless otherwise noted.

Pressure Connection: "Flush" diaphragm.

NEMA 6 rating (submersible to 2,300 feet).

Temperature Compensation: Plus 28 to 80 degrees F.

Dimensions: 5.9L by 1.0 diameter, inches, nominal.

Loop powered, 9-30V dc.

Open face with perforated Protective Plate: 1.35 diameter, inches.

Interconnecting Cable:

Length: As required.

Polyurethane sheathed.

Kevlar strain relief cord.

Integral vent tube.

Sensor Termination Enclosure:

Enclosure: NEMA 4X, PVC/polycarbonate.

Desiccant module.

Micro filter.

Wall and 2-Inch Pipe Mounting Kit: Required, unless otherwise noted.

Lightning Arrestor(s): Required, unless otherwise noted.

Signal Interface: 4 to 20 Ma dc output, for load impedance of 0 to 750 ohms, minimum for 24V dc supply without load adjustment.

Area Classification: Intrinsically safe; certified for use in Class 1, Division 1, Groups A, B, C, and D atmospheres.

Manufacturers:

Druck; Type PTX 1290 with STE110.

Pressure Systems, Inc. KPSI; Series 720 with Series 815 Aneroid Bellows and Series 840 Junction Box.

L109 Level Detection Switch, Rises on Stem:

General:

Function: Actuate contact at preset liquid level.

Type: Direct acting; rises on stem.

Service: Liquid, water, wastewater, unless otherwise noted.

Performance:

Set point as noted.

Switch Actuation Point: Approximately 3/4-inch distance from end of stem to weighted support collar.

Operating Temperature Range: Minus 40 to plus 110 degrees F.

Features:

Assembly Material: Brass stem, Buna N Float, and Type 316 stainless steel wetted parts.

Float Size: 2-inch diameter.

Mounting: Suspension cable with compact-sized float, slosh shield, and weighted collar suspended in standpipes or sumps for leak detection.

Signal Interface:

Switch Type: Magnetic reed switch.

Switch Contacts:

SPST Isolated, rated at 20 VA.

NC (by inverting float on unit stem).

Cable and Lead Wires: No. 22 AWG, 25 feet of length of PVC jacketed cable.

Manufacturer and Product: GEMS; Specialty Switches Liquid Level Switch, Model LS-750.

M12 Hand Switch and Light, Oiltight, Round:

General:

Function: Select, initiate, and display discrete control functions.

Type: Heavy-duty, oiltight, industrial.

General Features:

Mounting: 30.5 mm single round hole. Panel thickness 1/16 inch to 1/4 inch.

Legend Plate: Standard size square style aluminum field and black markings, unless otherwise noted. Markings as shown.

Configuration: Light, pushbutton, or switch as noted or shown.

Light Features:

Lights: 6V ac lamps and integral transformer for operation from 120V ac, unless otherwise noted.

Lens Color: Color as specified under PANEL, STANDARD LIGHT COLOR AND INSCRIPTIONS, or as noted.

Pushbutton and Switch Features:

Guard: Full guard with flush button, unless otherwise noted.

Operator: Black pushbutton, black non-illuminated knob on switch, unless otherwise noted.

Boot: None, unless otherwise noted.

Signal Interface:

Contact Block:

Type: Silver-coated butting, unless otherwise noted.

Rating: 10 amps continuous at 120V ac or as noted.

Sequence: Break-before-make, unless otherwise shown.

Arrangement: Normally open or normally closed as shown, or perform functions noted.

Terminals: Screw with strap clamp, unless otherwise noted.

NEMA Rating: NEMA 4, watertight and dusttight and NEMA 13, oiltight.

Manufacturers/Models:

Allen-Bradley; Bulletin 800T.

Eaton Corp.; Cutler-Hammer, Type 10250T.

Square D Co.; Class 9001, Type K.

M31 Warning Light, Indoor/Outdoor:

General:

Function: Visual alarm.

Type: Rotating reflector or flashing bulb.

Parts: Light and spare bulbs.

Performance:

Temperature, Operating: Minus 35 to 190 degrees F.

Flash Rate: Nominally 90 per minute.

Features:

Dome Color: Amber, unless otherwise noted.

Lamp Life: 200 hours.

Lamp: Incandescent/25 watts.

Enclosure:

Type: Water-resistant closed cell neoprene gasket.

Mounting: Wall bracket, unless otherwise noted.

UL Listing: Indoor/outdoor use.

Power: 120V ac, 50/60-Hz.

Spare Bulbs: Two for each light.

Manufacturers:

Federal Signal; Model 225.

Benjamin Electric Manufacturing; Series KL-4000.

P4 Pressure Gauge:

General:

Function: Pressure indication.

Type: Bourdon tube.

Performance:

Scale Range: As noted.

Accuracy: Plus or minus 0.50 percent of full scale.

Features:

Liquid Filled: Required unless otherwise noted.

Glycerin fill, unless otherwise noted.

Dial: 4-1/2-inch diameter, unless otherwise noted.

Case Material: Black phenolic plastic, unless otherwise noted.

Element Material: Phosphor-bronze, unless otherwise noted.

Throttling Devices:

Pulsation dampener required, unless otherwise noted.

Brass, unless otherwise noted.

Pointer: Micrometer-adjustable.

Movement: Stainless steel, Teflon coated bearings, rotary geared.

Window: Glass, unless otherwise noted.

Socket Materials: brass, unless otherwise noted.

Threaded reinforced polypropylene front ring for easy zero adjustment.

Case Type: Solid front with solid wall between window and element. Rear of case, gasketed pressure relief.

Process Connection:

Mounting: Lower stem, unless otherwise noted.

Size: 1/2 inch, unless otherwise noted.

Connection Type: Threaded (NPT).

Manufacturers and Products:

Ashcroft; Duragauge Model 1279/1379.

Weksler; Royal Process Gauge Model AAXX.

Ametek U.S. Gauge; Solfrunt Model 19XX.

P6 Pressure Seal, Diaphragm:

General:

Function: Isolate sensing element from process fluid.

Type: Fluid filled, corrosion resistant.

Service:

Pressure: Same as associated sensor.

Temperature: As noted.

Features:

Material Lower Housing: Type 316 stainless steel, unless otherwise noted.

Diaphragm Material: Type 316 stainless steel, unless otherwise noted. Bleed screw in upper housing.

Fill Fluid: As noted. Factory filled and assembled when possible.

Process Connections:

Instrument: 1/2-inch female NPT, unless otherwise noted.

Process: 1/2-inch female NPT, unless otherwise noted.

Connection Material: compatible with pressure indicator and process lines.

Manufacturers:

Ametek, Mansfield and Green Division; Type SG.

Ashcroft; Type 101.

S27 Indicator, Digital Panel:

General:

Function: Display analog signal, or totalize analog signal, and display engineering units.

Type: 7-segment digital, horizontal edgewise.

Performance:

Range: As noted, engineering units as noted.

Accuracy: Plus or minus 0.1 percent full scale.

Temperature, Operating: 32 to 120 degrees F.

Features:

Digits: 4-1/2; 0.56-inch high minimum; 7-segment LED, gas plasma, or vacuum fluorescent.

Decimal Point: Field selectable.

Input Impedance: 100 ohms maximum.

Service Legend: Permanent, display of engineering units.

Response Time: 1 second maximum to 0.1 percent accuracy.

Signal Interface: 4 to 20 mA dc.

Enclosure:

Type: NEMA 4X.

Mounting: Panel; approximately 2-inch high, 4-inch wide, 5-inch deep.

Power: 120V ac, 50/60-Hz unless otherwise noted.

Manufacturers:

Red Lum Controls.

Action Instruments.

Analogic.

Moore Industries.

T3 Temperature Element and Transmitter, Resistance:

General:

Function: Measure the temperature of ambient, and transmit analog signal proportional to temperature.

Type: RTD.

Parts: Element and transmitter.

Service:

Process: As noted.

Process Temperature Range: As noted.

Element:

Type:

Single-element, unless otherwise noted

Three-wire, RTD.

Platinum, 100 ohm nominal at 0 degrees C.

Performance:

Accuracy: Greater of plus or minus 4 degrees F or plus or minus 0.75 percent of reading.

Features:

Dimensions: 1/4-inch diameter.

Length to accommodate thermowell insertion and extension lengths.

Spring-loaded element when well is used.

Sheath:

Type 316 Stainless Steel, unless otherwise noted.

Process Operating Temperature Range: Minus 320 to 900 degrees F, unless otherwise noted.

Terminal Connection Head:

General purpose, NEMA 4 weatherproof, unless otherwise noted.

Maximum Temperature: 220 degrees F, unless otherwise noted.

Thermowell Connection: Union Coupler, unless otherwise noted.

Sensitive Length: 1.6 inch minimum, measured from closed end.

Transmitter:

Ambient Operation Conditions.

Temperature: minus 40 to 140 degrees F, with display.

Relative Humidity: 0 to 100 percent, noncondensing.

Type: Two-wire, powered by a remote power supply.

Performance:

Accuracy: Greater of plus or minus 0.7 degree F or plus or minus 0.06 percent of span.

Response Time: 1.2 second 90 percent response time for 80 percent input step, with minimum damping.

Electrical Safety: Standard unless otherwise noted.

Features:

Indicator: Three line LCD, unless otherwise noted.

Automatic reference junction compensation.

Failsafe Mode:

User configurable ON, unless otherwise noted.

Downscale, unless otherwise noted.

Electric Damping: 1.2 seconds.

Signal Interface: 4 to 20 mA dc

Power: 24V dc external power supply.

Digital Communication: HART.

One HART communicator to be supplied for all HART capable transmitters, if not already supplied under another Specification section.

Enclosure:

Materials: Epoxy coated, low-copper aluminum, unless otherwise noted.

Type: NEMA 4X.

Mounting: Wall, as noted.

For wall, provide stainless steel mounting set, unless otherwise noted.

Manufacturers and Products:

Foxboro; RTT20 Series Transmitter with PR Series RTD and Thermowell.

Rosemount; 78 Series Platinum RTD and Model 644H Transmitter.

Y40 Uninterruptible Power Supply System:

General:

Function: Provides isolated, regulated uninterrupted ac output power during a complete or partial interruption of incoming line power.

Major Parts: Inverter, a battery charger, sealed battery.

Performance:

Capacity: As noted.

Input Power:

120V ac single-phase/60 Hz, unless otherwise noted.

Connections: As noted.

Output Power:

120V ac single-phase/60 Hz, unless otherwise noted.

Connections: As noted.

On-line Efficiency: 85 percent minimum, unless otherwise noted.

Backup Runtime:

Full Load: 9 minutes minimum, unless otherwise noted.

Half Load: 24 minutes minimum, unless otherwise noted.

Continuous no-break power with no measurable transfer time.

Sine-Wave Output Power Regulation:

Plus or minus 5 percent or less total harmonic distortion.

Meet or exceed CSA C22.2 No. 107.1 for harmonic distortion.

Voltage Regulation: Plus or minus 3 percent nominal.

Operating Temperature: 0 to 40 degrees C (32 to 104 degrees F).

Lightning and Surge Protection:

Pass lightning standard ANSI/IEEE C62.41 Categories A and B test.

2000 to 1 attenuation of input spike.

Isolation:

True separately derived power source as per NEC Article 250-5d with output neutral bonded to ground.

Complete from line.

Less than 2 pF effective input to output capacitance.

Features:

Enclosure: Floor mounted cabinet, unless otherwise noted.

RS232 external interface with full-duplex output capable of:

Remote monitoring of meter functions and alarm conditions.

Remote diagnostic testing.

Remotely set point display and adjustment.

Manufacturers:

Best Power, FERRUPS Uninterruptible Power System.

Controlled Power.

American Power Conversion; Back-UPS Pro.

Y50 Programmable Logic Controller and Operator Interface Unit System:

General:

Function: Microprocessor based system configured, assembled, and programmed in order to implement the safe automatic control and measurement of process control equipment.

System incorporates programmable logic controllers, processors, power supplies, operator interface units, communication hardware, programming and development software, and cables, and programming laptop.

Programmable Logic Controller (PLC):

Function: Used for process monitoring and control by emulating functions of conventional panel mounted equipment such as relays, timers, counters, current switches, calculation modules, PID controllers, stepping switches, and drum programmers.

PLC Parts: Central processing unit (CPU), power supply, local input/output modules, local (chassis/rack) controllers, I/O terminals board and termination cable assemblies, and factory assembled programming laptop, ETHERNET and OIU communication interconnecting cables.

PLC Central Processing Unit (CPU) Specifications:

Type: Microprocessor, 16-bit minimum.

Memory: 32K words.

I/O Capacity: 4096 inputs, 4096 outputs.

Standard RAM with lithium battery for 2 years backup.

Scan Time: 0.9 ms/1K ladder logic.

Communications:

Two communication ports, RS-232/RS485 and 10BASE-T Ethernet channel.

10 Mbps communications – TCP/IP protocol.

RS-232 and DH-485 Communication protocols.

Instruction Set:

Timers and Counters.

Math: Signed integer and floating-point math including add, subtract, multiply, divide, square root, exponent, and compare.

Register Operations: Shift registers, bit shift, bit set, bit clear, data move and data format conversion.

Process Loop Control: User configurable direct or reverse acting PID loop control computation with the capability of both AUTO and MANUAL modes of operation, remote access to controller tuning constants.

Real Time Clock: Date and time set and compare.

Miscellaneous: Jump or skip to a label, one shot, quantity drums, pre-configured analog alarm functions, subroutines, quantity.

Environment:

Operating Temperature: 0 to 55 degrees C (32 to 131 degrees F).

Storage Temperature: -25 to 70 degree C (-13 to 158 degrees F).

Relative Humidity: (noncondensing) 5 to 95 percent at 0 to 55 degrees C (32 to 131 degrees F).

Heat Dissipation: 15 Watts.

<u>Agency Approvals and Standards:</u>

UL listed.

CSA certified.

or another state approved agency.

<u>Random Access Memory (RAM):</u>

<u>Type:</u> CMOS type.

<u>Word Size:</u> 16 bits, minimum.

<u>Battery Backup:</u> 24 months, minimum.

<u>Memory Size:</u> Sufficient to implement all applications software plus 50 percent spare.

Read only memory (ROM) for controller's operating system and diagnostics.

<u>Memory Protection:</u> Keylock switch.

<u>Manufacture and Product:</u> Allen-Bradley 1747-L552.

<u>PLC Power Supply:</u> One unit for each input/output base assembly.

<u>Voltage:</u> 120/220 volts (user selectable), 60 Hz input; 24 VDC output.

<u>Mounting:</u> Integral with PLC chassis.

<u>Manufacture and Product:</u> Allen-Bradley 1747-P4.

<u>PLC Input/Output:</u> Complete input/output system specifications:

<u>Discrete Input Modules:</u>

<u>Voltage:</u> 24 VDC.

<u>Operating Power:</u> 2 watts.

<u>Points per Module:</u> 16 maximum.

LED status indicator for each point.

Isolation: Between input point and PLC, 1,500 volts rms.

Discrete Output Modules:

Voltage: 24VDC.

Operating Power: 2 watts.

Load Rating: 2 amps continuous.

Isolation: Between PLC and output point, 1,500 volts rms.

Points per Module: 16 maximum.

LED status indicator for each point.

Isolated Discrete Output Modules:

Type: Isolated Form C relay.

Voltage: 120 volts, 60-Hz.

Isolated Outputs per Module: 8 Maximum.

Load Rating: 2 amps continuous.

Operating Power: 2.5 watts.

LED status indicator and fuse for each point.

Analog Input and Output Modules:

Voltage: 24 volts dc.

Power: 3 watts.

Differential Analog Points Per Module: 8 maximum.

Isolated Analog Output Points Per Module: 8 maximum.

Isolation: Between PLC and I/O point and between I/O points, 1,500 volts rms.

Analog Input Resolution: 12 bits minimum.

Analog Output Resolution: 12 bits minimum .

Manufacturer and Series: Allen-Bradley 1746 Series.

Operator Interface Unit:

Function: Panel mounted terminal unit with color video display screen and keypad which enable an operator to monitor and interface with the process control system programmable logic controller. OIU linked with PLC over ETHERNET network.

Type: Microprocessor based device and programmable using Microsoft Windows based development software. *(Note: PICS PLC and OIU design is based upon the Allen-Bradley SLC-5/05E programmable logic controller and the Allen-Bradley Panelview 600 operator interface unit).*

Parts: Central processing unit (CPU), power supply, video display touch screen, keypad, Ethernet and printer ports.

Specifications:

Electrical: DC Power Supply Limits: 85 to 264 VAC AC Power, Power Consumption 60 VA maximum.

Mechanical: Enclosure NEMA Type 12/13, 4X (Indoor use only), LED Indicators – "Green" COMM, "Red" FAULT.

Display: Active Matrix Thin Film resistor (TFT) with cold cathode fluorescent (CCF) backlight.

Size: 4.54 x 3.4 in.

Pixels: 320 x 234.

Touch Cells: 128 (16 columns x 8 rows).

Touch Cell Size: (20 x 29 pixels).

Terminal Memory: total application flash memory 240K bytes (application screens)

Environment:

Operating Temperature: -0 to 55 degrees C (32 to 131 degrees F).

Storage Temperature: -25 to 70 degrees C (-13 to 158 degrees F).

Relative Humidity: (noncondensing) 5 to 95 percent at 0 to 55 degrees C (32 to 131 degrees F).

Heat Dissipation: 32 Watts.

Agency Approvals and Standards: UL, CSA certified, or another state approved agency.

Manufacturer and Model: Panelview600 or equal.

Software Packages:

PLC Programming: Microsoft Windows based RSLogix500 programming and communication software (RSLinx) with master disk, most recent revisions, and 2-year support.

OIU Programming: Microsoft Windows based Panelbuilder32 development software with master disk, most recent revisions, and 2-year support.

Ethernet Switch:

Function: Mixed Media 10/100 Base T 8 port modular fiber switch with 4 port fiber module and 4 port RJ45 dual speed module.

Specifications:

Address Table 24K nodes with address aging.

Cooling Method: Internal 9-CFM fan.

Filtering and Forwarding Rate: 16-port aggregate, 2380K packets per second.

Latency, 100 Mbps: 5 μs + packet time; 10 Mbps: 15 μs + packet time, Packet Buffers 8 MB dynamic.

Processing Type: Store and forward with IEEE 802.3x full-duplex flow control

Standards: IEEE 802.3: 10BASE-T, 10BASE-FL; IEEE 802.3u: 100BASE-TX, 100BASE-FX.

Connectors:

LE1401A, (1) power.

LE1419C: (4) pairs of SC.

LE1425C: (4) RJ-45.

Indicators Chassis: Power; Per port: LK: ON when link is operational; Act: ON with port activity; FDX/HDX: ON for full-duplex mode, OFF for half-duplex mode; 100/10: ON for 100 Mbps, OFF for 10 Mbps

Power Input: 110–240 VAC, 47–63 Hz, internal, autosensing; 20 W.

Size: 1.75 inches high (1U) by 17 inches wide by 9 inches deep (4.4 x 43.2 x 22.9 cm); weight: 2.5 pounds (1.1 kg).

Agency Approvals and Standards: UL, CSA or another state approved agency.

Manufacturer and Product: Black Box LE1401A; or equal.

Programming Notebook (Laptop) Computer:

Function: Notebook computer used to implement, test, and store all PLC and OIU application software programming. Install and configure all PLC and OIU vendor software packages and licenses onto laptop. Complete and save application software to notebook computer and to backup R/W CD(s).

Specifications:

Processor 2650: Intel Pentium 4-M processor at 2.0 GHz, 512 KB cache.

Memory: 128 MB DDR SDRAM standard, upgradable to 512 MB maximum, SDRAM configurations include one of 128, 192, 256, 384 or 512 MB.

I/O Ports:

25-hole pin parallel connector.

15-pin monitor connector.

6-pin PS/2-style keyboard, mouse, and keypad.

2-USB (Universal Serial Bus) compliant 4-pin connectors.

RJ-11 connector for modem.

RJ-45 connector for connection to Ethernet multimedia switch.

Chassis:

14.1-inch XGA Display: Height: 36 mm (1.42-inch); width: 328 mm (12.9-inch); depth: 275 mm (10.8-inch); weight: 7.25 lbs. with CD, floppy and battery.

Display: Displays 15-inch SXGA+ TFT active-matrix display with 1400 x 1050 resolution; height: 38 mm (1.5-inch); width: 332 mm (13.1-inch); depth: 275 mm (10.8-inch).

Power: Lithium Ion battery, AC Adapter: Input voltage: 90 to 135 VAC and 164 to 264 VAC.

Slots: Connectors: (1) Type I or Type II card, 3.3 and 5 V cards supported, Warm-swap Capable.

Graphics: 16MB DDR 4X AGP NVIDIA® GeForce2TM.

Storage: 20 GB4 Ultra ATA hard drive.

Optical Devices:

Fixed Bay integrated in left side with CD-RW: 24x/10x/24x max.

Removable Media: Fixed Floppy drive standard.

Communication Devices: Network Interface Cards, Integrated 10/100 network interface card.

Modems: Standard: Internal 56K5 capable v.92 Fax modem .

Software & Accessories: Microsoft® Windows® 2000 or XP Professional Small Business most recent version. Insure compatibility between platform and vendor software packages prior to installation.

Utilities: Norton AntiVirusTM 2003, introductory version.

Manufacturer and Model: Dell Inspiron 2650 or equal.

Y178A Programmable Data Logger, Integral Solar Powered:

General:

Function: Programmable data logger and system capable of interfacing with process measurements loop powered analog device(s) for the purpose of measuring, collecting, storing and serially transferring process level data with externally connected programming and storage device (i.e. laptop computer).

Type: Microprocessor based.

Parts: Data logger, input/output channel, signal converter, communications, rechargeable battery, solar panel, charge controller, enclosure, and programming and data retrieval software. Vendor shall provide complete system meeting the intent of these specifications and contract drawings.

Service: Interface with Level/Element Transmitter, Submersible, Wastewater (Reference Section 13401 PICS Component L42 for detail information, Druck PTX 1290 and STE110 Level Element/Transmitter Submersible 12 V dc compatible or equal).

Performance:

Environmental:

Operating Temperature: Minus 67 degrees F to plus 185 degrees F (minus 25 to plus 85 degrees C), with gel cell battery, minus 40 degrees F to plus 140 degrees F (minus 40 to plus 60 degrees C).

Relative Humidity: 5 to 95 percent, non-condensing.

Central Processing Unit (CPU):

Processor: Hitachi 6303.

Memory: table based memory structure 62,000 data points.

Real time clock.

Diagnostic LEDs.

12-bit A/D converter.

16kB active program.

128kB operating and flash final storage.

Comm Port: 9-pin D type connector for RS232 interface with PC; up to 9600 baud selectable baud rates.

Manufacturer and Model: Campbell Scientific; CR510 Series with extended temperature test.

Input/Output Channel:

Analog Inputs:

Two (2) differential or four (4) single ended configured.

Range: 0 to 2.5 V dc.

Accuracy: +/-0.25 percent.

Resolution: 0.33 uV.

Sample Rates: 2.72 ms adjustable.

Manufacturer and Model: Campbell Scientific; Model CR510.

Terminal Input Channel Converter:

Convert 4-20mA to datalogger input range of 0 to 2.5V dc.

Shunt Resistor: 100 ohms.

Tolerance: +/- 0.01 percent.

Power: 0.25 watt.

Manufacturer and Model: Campbell Scientific; Model CURS100.

DC Power Supply:

Solar Panel, Regulator and Mounts:

Solar panel converting sunlight to DC power.

Voltage Peak: 16.8 volts.

Current at Peak, amps: 1.19 amps.

Peak Power: 20 watts.

Manufacturer and Model: Campbell Scientific; Model MSX20R.

Rechargeable Power Supply with Batteries:

Rechargeable power supply capable of recharging batteries from solar power.

Sealed rechargeable batteries providing 7.0 AHRS nominal output at 68 degrees F (20 degrees C).

Float charged by solar panel.

Manufacturer and Model: Campbell Scientific; Model PS100.

Enclosure: NEMA 4X - fiberglass reinforced polyester (FRP) 16 inches wide by 18 inches high by 9 inches deep (minimum) sized to accommodate datalogger, input/output channels, DC power supply, and sensor terminations.

Enclosure Mounting: Wall or pipe mounting as required.

Power Requirements: 5.4V dc to 16V dc.

Software Language: Pakbus operating system, and Microsoft® Windows® 2000 or XP based Datalogger Support and editing software and licenses complete and latest versions.

Support: Two (2) eight-hour days in support of installation, startup, calibration, and testing of complete system.

Training: One (1) eight-hour day in support of Tank Farm Contractor training on operations, setup, data retrieval, and troubleshooting of complete system.

Warranty: Three (3) years complete system beginning after system installation is complete and tested.

Manufacturer: Campbell Scientific.